

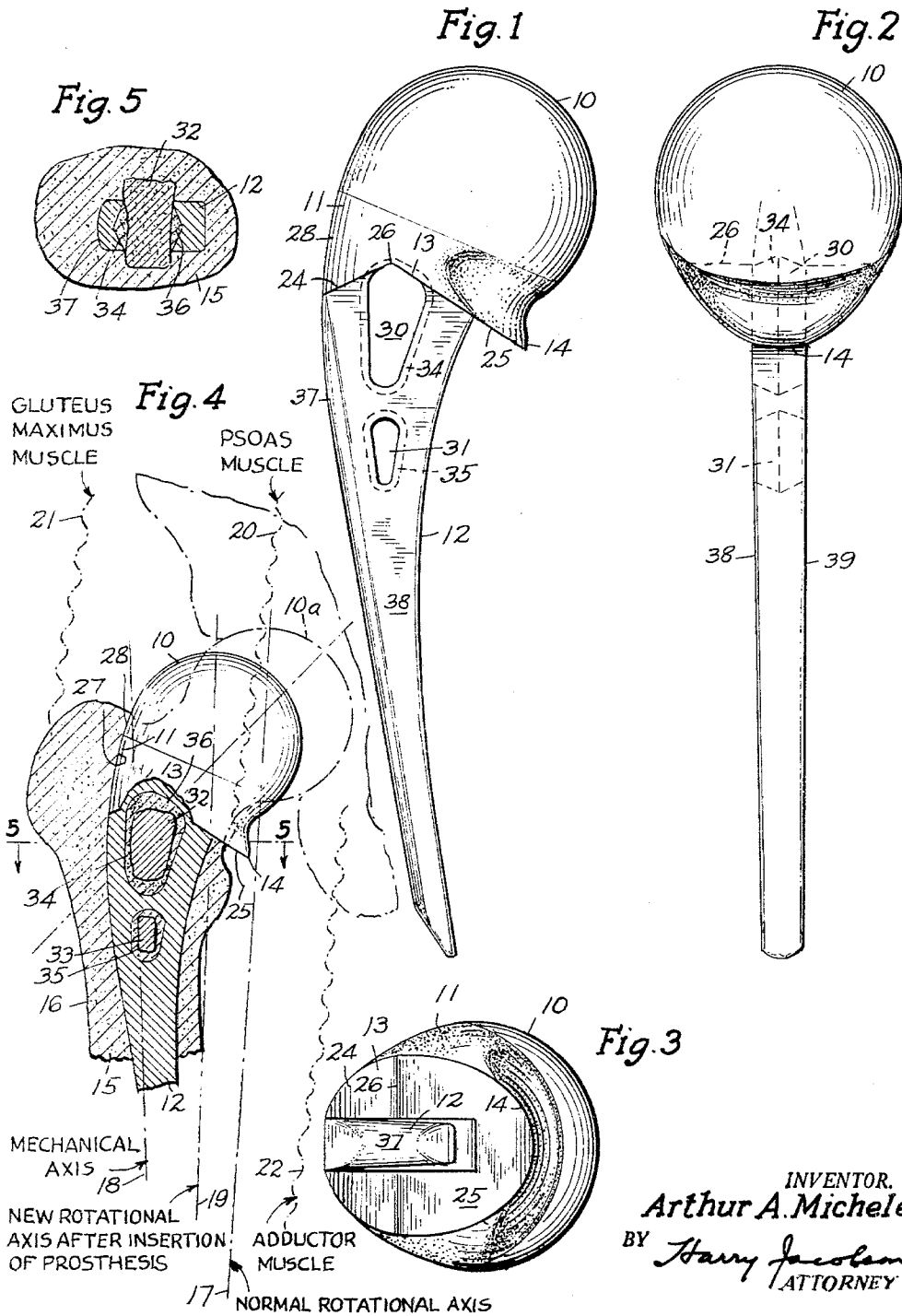
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HIP REPLACEMENT PROSTHESIS

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HIP REPLACEMENT PROSTHESIS

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This invention relates to prostheses and particularly to that type intended to replace the head of the femur (thigh bone).

Aside from occasional instances of the use of femoral head replacement prostheses for direct traumatic fractures (non-torsional) of the neck of the femur, in rheumatoid arthritis, metastatic lesions of the head and neck of the femur and some other situations, indications for the use of such prostheses are in the main predicated upon those lesions which have been directly or indirectly initiated by disturbed iliopsoastic states or malfunctioning of the iliopsoas muscle (composite muscle of the iliacus and psoas major). The psoas major is the only muscle of the spinofemoral group. Through this component, the iliopsoas possesses a powerful anterior bending moment at the level of the neck of the femur. This factor is of importance in consideration of the development of anomalies in man as set forth in detail in the book entitled "Iliopsoas; Development of Anomalies in Man" by Arthur A. Michele, M.D., published by Charles C. Thomas, Springfield, Ill., 1962.

The iliac component of the muscle takes its origin from the level of the iliac fossa, the psoas component from the transverse processes and lateral bodies of the 12th dorsal and all the lumbar vertebrae. The combined muscle fibers pass over the anterior brim of the pelvis to insert into the lesser trochanter of the femur and somewhat below.

We may assume that the iliopsoas may develop in an adult a tension of approximately one thousand pounds or more in full contraction. Because of the various normal shearing compressive and torsional stresses and bending moments exerted by the musculature, it should be obvious that a fracture of the neck of the femur may occur even with only trivial assistance from an outside source. In addition, when stresses other than normal are exerted by the musculature and loads upon the femoral neck, hip arthroplasty may eventually become necessary. It is suggested that the prosthesis of the present invention is useful in the following deformities, all having as a primary or at least a contributory causative factor, an iliopsoastic syndrome.

(1) Treatment of fractures of the neck of the femur in (a) elderly persons (over 65 years of age), (b) where the fracture line is vertical indicating an unfavorable result in the healing process of the fracture;

(2) treatment of aseptic necrosis of the head of the femur;

(3) advanced degenerative arthrosis of the coxofemoral articulation;

(4) replacement of the femoral head and proximal neck as a salvaging procedure in cases of malignancy of the head and neck (pathological fractures thereof);

(5) bilateral ankylosis of coxofemoral articulation;

(6) replacement of the head and neck of the femur in severe deformities of the head and neck as in advanced stages of slipped capital epiphysis, and Legg-Perthes disorder with unstable and painful and partially ankylosed coxofemoral articulation.

Deformities of the hip, such as developmental hip dislocation, osteochondrosis of the proximal femoral epiphysis and slipped femoral capital epiphysis, may be looked upon as means by which man, because he harbors within himself the potential of an abnormal destructive force, must compromise in order to maintain the distinc-

tive erect posture which apparently has been a goal in his anthropological progression.

Replacement of the pivotal ball or head of the femur does not alter or moderate the abnormal intrinsic force of the iliopsoas. What does occur is simply a shifting of the force directly to the acetabulum (socket in the pelvis for the femoral head) with secondary destruction of the articular cartilage of the wall and roof. It is not to be expected that simple insertion of a new femoral head will modify to any degree the state of contracture or the basic intrinsic force responsible for destruction of the joint structures in the first instance.

In the past, the best results with prosthesis have been achieved in those cases in which the individual maintained the attitude of the hip joint at the anthropological level of hip flexion of the Neanderthal man. If an attempt is made to regain the erect posture (90° axial rotation, extension of hip and knee, normal pelvic tilt and lumbar lordosis) which modern man has established as normal, the destructive force of the iliopsoas will again take over.

The present invention is based on the theory just expressed as well as on experience in the use of femoral head prosthesis in many of the situations mentioned and the close relationship of the iliopsoastic force to the formation of the calcar femorale (strongest part of the femur), antetorsion of the neck of the femur, and coxa valga and coxa vara (turning of the femoral head and neck to other than a normal angle to the shaft of the femur). This force acquires an abnormal destructive quality when there is contracture or failure of elongation of the muscle. The external rotational force in abnormal proportion in a weight-bearing extremity is a main contributor toward the torsion fractures of the neck of the femur, non-union, aseptic necrosis and degenerative changes of the articulation.

The problem having been discovered as stated, the solution follows that in the preliminary surgical management there must be a complete release of all the structures that contribute to the external rotation-flexion-abduction contracture of the hip joint, such as capsulotomy, tenotomy of the adductor or any thigh flexor, including the band if indicated.

In the past, in those fractures of the femoral neck where normally there exists about 10-12° or less of antetorsion, insertion of the 30° antetorsion available replacement prosthesis invariably has been followed by its dislocation from the acetabulum, or frequently stress pain phenomena at the level of the coxofemoral articulation. A neutral neck prosthesis has eliminated one of the variables of the intrinsic force, namely, antetorsion, thereby eliminating dislocation following insertion; however in many instances, sequential shearing stress remained.

The present invention is directed toward the provision of a prosthesis especially serviceable in instances of severe flexion and adduction ankylosis associated with degenerative arthrosis of the coxofemoral joint and the other lesions and deformations previously mentioned, in that the prosthesis obviates the necessity of detorsion, increased valgidity of the neck and intertrochanteric osteotomy, and additionally posterior wedge resection at the subtrochanteric level of the femoral shaft.

The invention is further directed toward the provision of a prosthesis adjusted to effect a 15-20° anterior angulation of the subtrochanteric level (base of neck) thereby conforming to kinesiological principles and decompressing the abnormal force of the adductors, glutei and iliopsoas (neutralizes the external rotary force) and compensates for the residuals of flexion contracture of the hip, and thus permits the erect posture.

The invention is further directed to the provision of a prosthesis compensating for the lesions at either end of

the multipolar muscle when failure of adequate elongation of the iliopsoas occurs.

The invention is still further directed to a prosthesis so constructed that within the level of its neck an oblique shifting of the angle of the femur toward the vertical is accomplished by detorsion and the partial release of the force of the iliopsoas, adductor magnus and gluteus maximus, with neutralization of the anterior bending moment of the femoral neck. Such change in angularity permits the transfer of loads with better mechanical efficiency and direction to the shaft of the femur while relieving the head and neck of the otherwise destructive forces to a substantial extent of torsion, shearing and bending. The prosthesis is also constructed and shaped with adequate recesses in the neutral neck thereof and in the stem fenestras for proper anchoring thereof and bone grafting and entrapment of the calcar femorale (cortical bone).

The various objects of the invention will be clear from the description which follows and from the drawings, in which

FIG. 1 is an elevational view of the prosthesis.

FIG. 2 is a side elevational view thereof.

FIG. 3 is a bottom plan view thereof.

FIG. 4 is a fragmentary vertical sectional view of the upper end of the prosthesis showing it in its operative position assembled to the femur and showing diagrammatically and in dash-dot lines, the acetabulum and the musculature which stresses the femur, as well as the axes of the parts.

FIG. 5 is a horizontal sectional view taken on the line 5—5 of FIG. 4.

In that embodiment of the invention shown by way of example, the prosthesis is made of suitable material which is clinically inert, exhibits minimal foreign body reaction and is non-electrolytic such as stainless steel alloys and acrylic. For ease of description, the left hand side of the prosthesis as viewed in FIG. 1 and FIGS. 3-5 will be referred to as the "outer" side of the right hand side as the "inner" side. The prosthesis comprises the solid head 10, the solid neutral neck 11, the stem 12, the apron 13 at the bottom of the neck and the lip 14 on the inner side of the apron. The spherical surface of that part of the head which in any position may enter the acetabulum 10a (FIG. 4) is highly polished and its area is almost two thirds of that of a sphere. The neutral neck 11 is a smooth, generally uninterrupted convexly curved continuation of the spherical head except along an area just above the projecting medial or inner lip 14 where a concavity is located between the lip and the adjacent part of the head. The neck is so shortened and shaped as to arrange the head as directly as possible over the shaft 15 of the femur 16 and to entrap the calcar when the stem 12 is inserted into the shaft, so that the center of the head is vertically above a point well within the lesser trochanter as shown in FIG. 4 and also preferably above and outwardly of the innermost point of the top of the stem 12 when the prosthesis is implanted in its operative position.

The length of the femur is not increased by the prosthesis so that the pelvis does not tilt. Instead, the angle between the normal rotational axis 17 and the mechanical axis 18, after assembly of the prosthesis and the femur in the position of FIG. 4, is reduced considerably. The rotational axis is the line joining the center of the head with the intercondylar axis at the lower end of the femur. The reduction is from an angle of approximately six degrees to one of approximately three degrees as shown by the new rotational axis 19, which falls proximally outside of the stem as best seen in FIG. 4. There is consequently substituted for the eccentric and indirect transfer of the superincumbent weight of the body to the shaft of the femur through its neck, the more nearly direct transfer of such weight as in a mechanical long column. The objectionable antetorsion effect of the neck of the femur or of prior prosthesis is thereby eliminated with release of the anterior bending moment exerted by the iliopsoas

at the level of the femoral neck. Shifting of the alignment of the head, neck and shaft from a normal to an abnormal angle as in an intertrochanteric osteotomy neutralizes the external rotational force of the psoas major muscle 20 and equilibrates the gluteus maximus muscle 21 and adductor musculature 22. By making it possible to place the head 10 directly over the femoral shaft 15, the shearing effect of the prosthesis over the medial portion of the lateral neck of the femur (calcar femorale) is decreased.

As has been previously mentioned, the prosthesis is so shaped as to provide means to anchor it firmly at the intertrochanteric area, as well as at the stem 12. For this purpose the neck 11, while generally cylindrical and short and arranged substantially coaxially of the head, is shaped to terminate in and to form an apron 13 with a trough-like recess of inverted V shape, the preferably planar walls 24 and 25 of which converge upwardly toward each other to meet at an edge or ridge 26 deep in the neck and extending on opposite sides of the stem 12. When the femoral neck is removed preparatory to the insertion of the prosthesis, part of the proximal end of the neck and head of the femur are cut to form an outstanding bony wedge conforming to the shape of the deep recess at the bottom of the neck of the prosthesis while the medial or inner surface of the lateral cortex 27 is shaped generally to conform to the shape of the smooth convexly curved lateral or outermost surface 28 of the head, neck and stem. The neck recess is so deep that the theoretical spherically shaped continuation of the spherical surface of the head 10 to completion extends below the ridge 26 and the upper parts of the walls 24 and 25. As the calcar wedge is received in the recess of the apron 13 and the wall 27 of the femur and the corresponding wall 28 of the prosthesis are fitted together, the prosthesis is adequately stabilized. The lip 14 of the apron projects sufficiently to overhang the medial edge of the calcar wedge and to insure maximal bearing contact with the end of the femur.

The fenestras 30, 31 in the relatively thin stem 12 are designed to carry bone grafts as 32, 33 respectively while the wall between the fenestras remains of full thickness and resists any tendency of the grafts to twist and turn. As best seen in FIGS. 4 and 5, a V-shaped groove 34 is made throughout and in the peripheral wall bounding the fenestra 30 and a similar groove 35 in the fenestra 31. The bone grafts pass through the fenestras, suitable cancellous bone as 36 being packed in the recesses and grooves 34, 35 ultimately to unite with the cortical bone of the grafts.

The stem 12 is of lesser width and thickness than that of the apron 13, while the lateral or outermost edge 37 of the stem is preferably convex longitudinally and merges smoothly with the convex lateral or outermost area 28 of the prosthesis. The faces 39 and 38 of the stem are preferably flat and converge slightly toward the lowermost end of the stem.

It will now be seen that by making it possible to reduce the rotational angle of the femur by means of the mechanically efficient alignment of the head of the prosthesis with the shaft of the femur, the beneficial effects of an intertrochanteric osteotomy are attained; that the various types of destructive stresses especially those due to the iliopsoas syndrome are substantially reduced or eliminated by the use of the prosthesis; that the prosthesis is adapted for firm and dependable anchorage preventing twisting and turning of the bone grafts therein and that the various objects of the invention have been adequately attained.

While certain specific forms of the invention have herein been shown and described, obvious changes may be made therein without departing from the spirit of the invention defined by the appended claims.

I claim:

1. In a hip prosthesis having a spherical head, a neutral

neck and a stem depending from the neck, the neck terminating at the bottom thereof in an apron having a peripheral portion overhanging the upper end of the stem except at the outermost upper end portion of the stem, said upper end portion being divided into two branches having a space therebetween beginning at and extending downwardly from the apron, the apron having an intermediate area arranged between said branches and closing the top of said space and constituting a continuation of the overhanging peripheral portion, the apron being in the shape of an inverted V having the outer side thereof shorter than the inner side, the stem being curved in a sufficiently large radius to arrange the head directly above the lower end of the stem in the implanted operative position of the prosthesis.

2. The prosthesis of claim 1, the overhanging peripheral portion terminating at the junction of the outer lateral surface of the stem with the outer lateral area of the surface of the neck.

3. The prosthesis of claim 1, the apron comprising a pair of planar surfaces each inclined upwardly toward the other of said surfaces and intersecting at a ridge extending across the space from one side to the opposite side of the peripheral portion.

4. In a hip replacement prosthesis having a spherical head and a depending neck terminating in an apron, a stem of lesser width and thickness than the apron projecting downwardly and substantially centrally from the apron, a convex surface on the neck portion extending to the periphery of the major part of the apron except at the innermost part of the apron, and a longitudinal convex uninterrupted continuation of said surface on the outer lateral upper part of the stem, the apron being of inverted V shape and overhanging the top of the stem on three sides, the neck being sufficiently short and the stem being shaped in a sufficiently shallow curve of sufficient length to arrange the head substantially directly over the bottom of the stem in the implanted operative position of the prosthesis.

5. The prosthesis of claim 4, the junction of the outer lateral surface of the stem with the convex surface of the head being smooth and free of projections, depressions and obstructions, which would otherwise interfere with the terminal part of the downward implanting movement of the stem into the medullary canal of a human femur, the upper part of the stem having a space therethrough extending downwardly from the apron and closed at the top by the apron, the space dividing said upper part of the stem into two branches.

6. The prosthesis of claim 5, the center of the spherical head portion, the lowermost point of the inner surface of the stem and the junction of said inner surface with the base lying substantially in the same straight line.

7. A head replacement hip prosthesis for the permanent elimination of antetorsion in the human femur, for reducing the rotational angle of and for substantially erecting the femoral shaft, comprising a spherical replacement head, a neutral neck depending from the head and terminating in a bone-engaging apron having a pair of intersecting upwardly inclined surfaces extending across the neck and meeting at a ridge nearer the outermost point of the apron than said ridge is to the innermost point of the apron, a stem being of lesser width and thickness than the neck and having a pair of uppermost branches depending from the neck, the upper ends of said branches being spaced apart transversely and being separated by that area of the apron adjacent the ridge, the major part of the apron overhanging the stem, the remaining part of the apron base terminating at the outer lateral surface of the stem, said outer lateral surface merging smoothly with the outer surface of the neck at the junction thereof, whereby the apron can be seated on a wedge shaped upper end of a femur and against the in-

ner surface of the greater trochanter, the center of the head and the innermost points of the top and of the bottom of the stem being approximately in alignment with each other.

8. In a hip replacement prosthesis having a spherical head, a neck and a stem, an inverted V-shaped apron on the bottom of the neck having a pair of substantially planar surfaces meeting at a ridge nearer the outermost part of the apron than said ridge is to the innermost part of the apron, the outer one of said surfaces being shorter than the inner one of said surfaces, the apron, the stem being bifurcated at its junction with the apron to provide a bone-graft receiving space extending downwardly from the apron to the bottom of the bifurcation of the stem, the top of said space being closed by the apron, the top of the stem being narrower and thinner than the apron and overhung thereby, an element on the neck inwardly overhanging and shielding the junction of the innermost point of the top of the stem with the apron, the head being arranged substantially directly above the bottom of the stem in the implanted operative position of the prosthesis.

9. In a hip prosthesis, a substantially spherical head, a relatively short neutral neck depending from the head and a stem depending from the bottom of the neck, said bottom constituting an apron of inverted V shape and comprising a relatively short outer wall and a longer inner wall, the walls converging upwardly toward each other and intersecting at an uppermost ridge in said apron, the inner wall of the apron extending inwardly and downwardly from the ridge past the innermost point of the top of the stem, the lowermost and outermost point of the apron being coincident with the uppermost and outermost point of the stem, the overall width of the apron measured from front to back being greater than the thickness of the top of the stem, the apron overhanging the front and back edges of said top, the upper end portion of the stem being bifurcated to provide two branches having a space therebetween, one branch depending from the short wall and the other branch depending from the longer wall, the top of the space being closed by said walls, the upper part of the stem having an outermost convex lateral surface and the neck having an outermost convex surface extending downwardly to the top of the convex surface of the stem and substantially continuous therewith, the center of the head being above and outward of the innermost point of the top of the stem in the implanted operative position of the prosthesis, said innermost point of the top of the stem and the innermost point of the bottom of the stem being approximately in alignment with the center of the head.

10. In a hip prosthesis having a spherical head, a neutral neck terminating in an apron and a stem projecting downwardly from the apron, a convex surface on the neck extending to the periphery of the major portion of the apron except at the inner part of the apron, a longitudinal uninterrupted continuation of said surface on the outer upper part of the stem, the apron overhanging the inner side, the back and the front of the upper end portion of the stem, said upper end portion being divided into two branches joined to the apron and having a space therebetween beginning at and extending below the apron, the central area of the apron constituting a closing wall for the top of said space, said area merging with the stem-overhanging portion of the apron, the apron including the closing wall thereof comprising a pair of planar surfaces intersecting at a ridge arranged at a level higher than the junction of the lower outer surface of the neck with the upper outer portion of the stem, the outer one of said planar surfaces being shorter than the inner planar surface and said surfaces constituting a bone-engaging area, the center of the head and the innermost upper and lower points of the stem being approximately in alignment with each other.

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