United States Patent

[11] 3,547,115

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[54] **OSTEOARTICULAR PROSTHETIC METHOD**
10 Claims, 13 Drawing Figs.

[52] **U.S. Cl.** **128/92;** 3/1
[51] **Int. Cl.** **A61f 5/04**
[50] **Field of Search** ..... 128/92, C, C1, 83, A—F; 3/1

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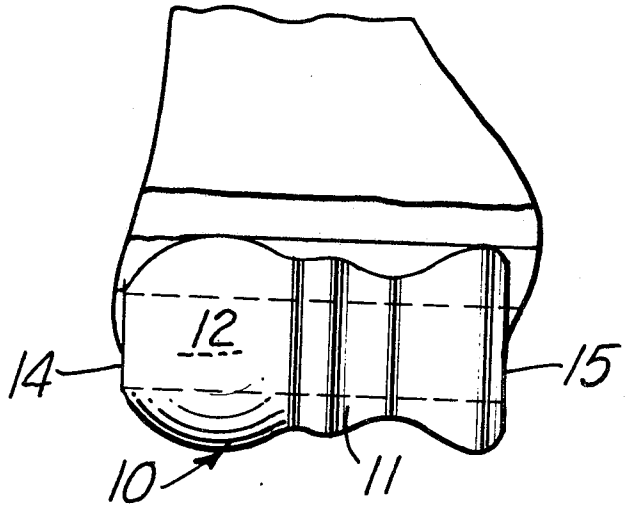
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ABSTRACT: An osteoarticular prosthesis and prosthetic method which is particularly adapted for use on the distal humerus. The prosthesis has an outer articular surface corresponding to the articular surface being replaced. The bone upon which the prosthesis is to be mounted is preferably first trimmed to fit a keyhole-type opening in the prosthesis. The prosthesis has a sharpened leading edge and is transversely driven onto the bone. Once in place, the prosthesis is locked against displacement by its keyhole-type interengagement with the bone. The prosthesis may be manufactured in quantity in a limited number of standard sizes instead of being custom made.



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SHEET 1 OF 2

FIG. 1.

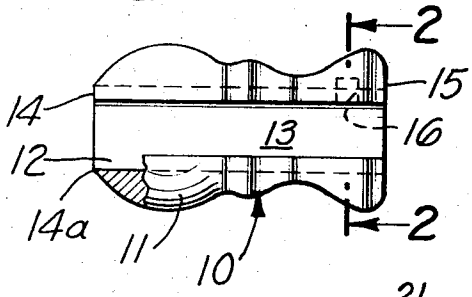


FIG. 2.

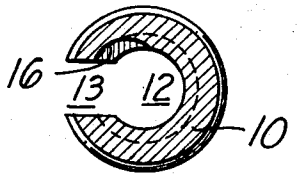


FIG. 3.

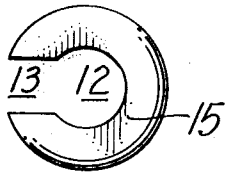


FIG. 4.

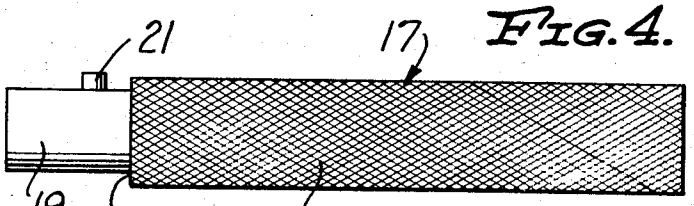


FIG. 5.

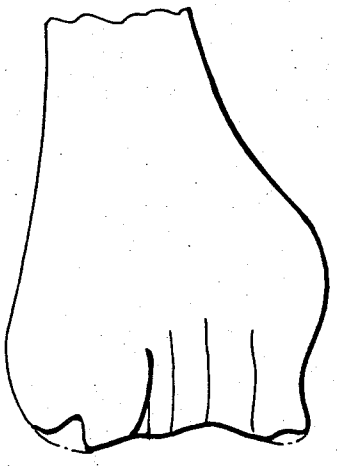


FIG. 6.

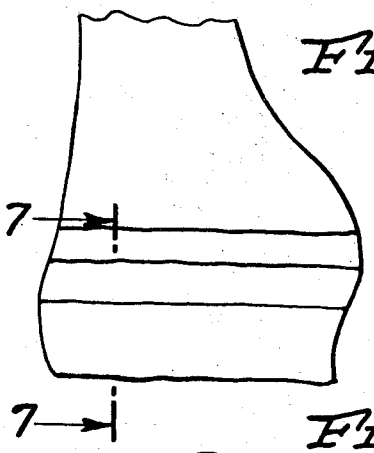


FIG. 7.

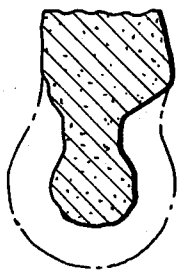
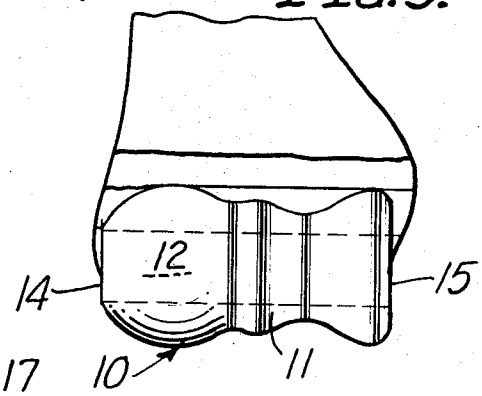


FIG. 8.

FIG. 9.



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FIG. 10.

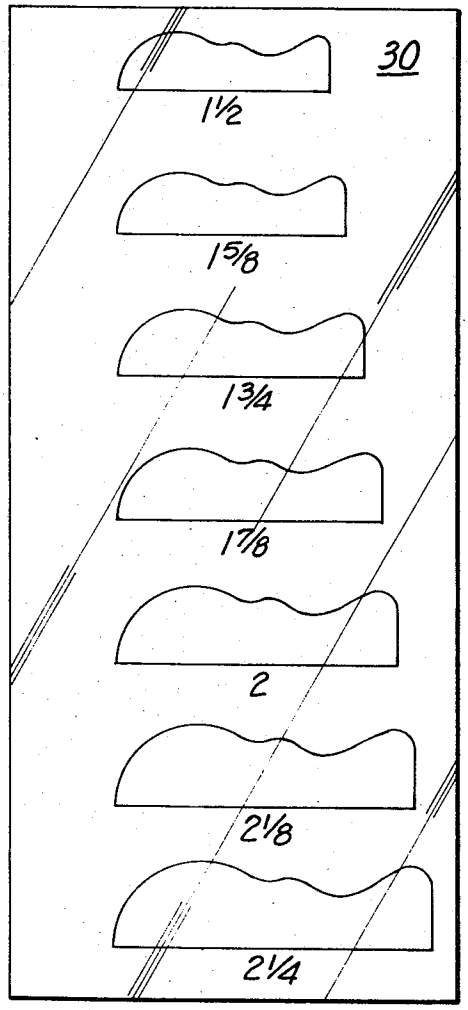


FIG. 11.

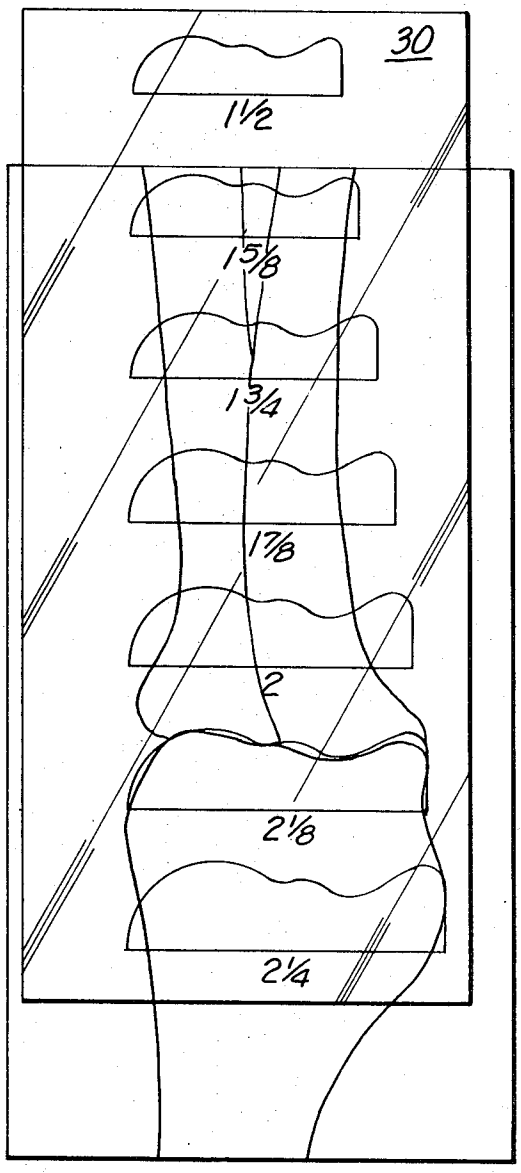
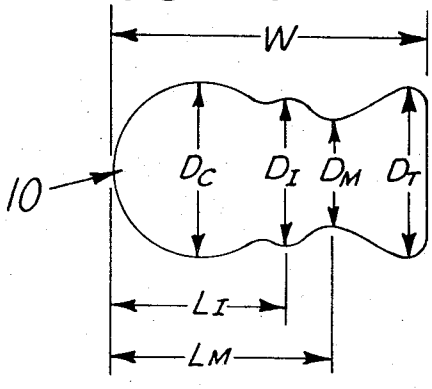


FIG. 12.



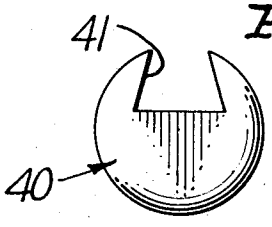


FIG. 13.

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OSTEOARTICULAR PROSTHETIC METHOD

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to an osteoarticular prosthesis and prosthetic method which is particularly applicable for use in replacing a defective distal humeral or similar articular surface.

2. Description of the Prior Art

The only joint in the body in which endoprostheses have been used with undisputed success is the hip joint. The reason is that the hip is a relatively simple joint which has lent itself to the design of simple prostheses which are not too difficult to emplace and which are maintained in position by the tension of the great leg muscles, rather than by multiple screws and other hardware.

Endoprostheses for other joints have been too complex, too cumbersome, too difficult to emplace, and/or too expensive to have met with wide use or notable success. Such has been the case with prior distal humeral prostheses.

Previous prosthetic devices designed to replace a defective distal humeral joint surface have consisted of a metal or plastic replica of the distal humerus which is attached to an intramedullary nail, with or without side plates. The prosthesis is affixed to a resected humerus by means of an intramedullary nail, and by screws through the side plates, if such are provided on the prosthesis. Such prostheses are not available on a mass-production basis, but are custom made by the prosthetics manufacturer from X-rays and measurements of each particular patient. Hence, they are very expensive.

The use of the above-mentioned prosthesis has been very limited because of several disadvantages: (1) The operation is an extensive one, requiring a wide exposure and necessitating the destruction of most of the joint capsule and the removal of the origins of a variable number of the forearm muscles. (2) The prosthesis tends to become unstable, because the intramedullary nail may rotate. (3) A considerable amount of bone is lost, since the distal humerus is replaced by prosthesis; and, if the prosthesis must later be removed, arthrodesis of the joint without marked shortening will be very difficult, if not impossible. (4) The prosthesis is complex in shape, difficult to manufacture, and hence is available only on a custom-made basis, and is necessarily expensive.

SUMMARY OF THE INVENTION

The invention relates to an osteoarticular prosthesis and method which are particularly adapted for use on the distal humerus and which overcome the problems of the previous devices and methods described above and in which the prosthesis meets all of the following requirements: (1) It must be chemically inert. (2) It must be easy to manufacture. (3) It must be so designed that several sizes will accommodate all distal humeral joints, to permit manufacture on a mass-production basis. (4) It must restore normal mechanics of the elbow joint. (In other words, both the hinge motion of the ulna and the hinge and rotational motion of the radius must be preserved). (5) It must be completely stable on the humerus. (6) It must spare bone, in case a later arthrodesis is required. (7) It must be easy to emplace. (8) It must be simple, and not require multiple screws, etc. to hold it in place. (9) It must be durable.

It is an object of the present invention to provide a prosthesis and prosthetic method in which the prosthesis comprises a member which is adapted to be driven transversely onto the partially trimmed articular surface of the bone. The prosthesis itself may further trim the bone as it is driven into place, to provide a perfect fit. The prosthesis provides an articular surface which replaces the articular surface of the joint, with the removal of a minimum amount of bone. In the case of the distal humerus, there is no cutting of muscle attachments and generally only the ulnar collateral ligament and medial capsule are incised.

It is particularly an object of the invention to provide a prosthesis which is held in place on the bone by a keyhole or similar interlocking engagement with the bone upon which it is mounted. Once in place, the prosthesis is completely stable and no pins or screws are required to maintain it in position.

Another object of the invention is to provide a prosthesis and prosthetic method particularly for the distal humerus in which a single shape of prosthesis in a limited number of standard sizes is provides an adequate fit for substantially all adults. The prosthesis is thus adapted to be manufactured in quantity, rather than being custom made. A comparison of an X-ray of the particular elbow with a template determines the proper size of prosthesis to be used. This prosthesis and method are accordingly far more economical than those requiring custom-made prostheses.

It is accordingly among the objects of the invention to provide a prosthesis and method having all of the advantages and benefits set forth above and described hereinafter in this specification. The invention also comprises such other objects, advantages and capabilities as will later more fully appear and which are inherently possessed by the invention.

While there have been shown in the accompanying drawings

Another object of the invention is to provide a prosthesis and prosthetic method particularly for the distal humerus in which a single shape of prosthesis in a limited number of standard sizes provides an adequate fit for substantially all adults. The prosthesis is thus adapted to be manufactured in quantity, rather than being custom made. A comparison of an X-ray of the particular elbow with a template determines the proper size of prosthesis to be used. This prosthesis and method are accordingly far more economical than those requiring custom made prostheses.

It is accordingly among the objects of the invention to provide a prosthesis and method having all of the advantages and benefits set forth above and described hereinafter in this specification The invention also comprises such other objects, advantages and capabilities as will later more fully appear and which are inherently possessed by the invention.

While there have been shown in the accompanying drawings preferred embodiments of the invention, the same are susceptible of modification and change without departing from the spirit of the invention.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a top plan view of a distal humeral prosthesis, with one end thereof partially broken away and shown in section to indicate the chisel-joint edge;

FIG. 2 is a sectional view of the same taken along line 2–2 of FIG. 1;

FIG. 3 is an end view of the medial end of the prosthesis;

FIG. 4 is a side elevational view of the driver;

FIG. 5 is a side elevational view of a damaged distal humerus before trimming;

FIG. 6 is a similar view of the same after trimming in preparation for mounting the prosthesis;

FIG. 7 is a sectional view of the same taken along line 7–7 of FIG. 6, with the trimmed portion indicated in phantom lines;

FIG. 8 is a side elevational view, showing the prosthesis being mounted on the humerus;

FIG. 9 is a side elevational view, showing the prosthesis in place on the humerus;

FIG. 10 is a plan view of a size template;

FIG. 11 is a plan view of the size template in use with an X-ray superimposed thereon;

FIG. 12 is a diagrammetical view of the prosthesis showing the dimensions used in determining the various sizes;

FIG. 13 is an end view similar to FIG. 3 of an alternative embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

A preferred embodiment which has been selected to illustrate the invention comprises an elongated generally cylindrical distal humeral prosthesis **10**, which can be formed of titanium, stainless steel or other suitable material. The prosthesis **10** has a curved outer or articular surface **11** which corresponds to the capitellar and trochlear portions of the elbow joint.

The center of the prosthesis **10** is drilled out to form a central cylindrical opening **12**, forming an inner open area which extends substantially along the longitudinal axis of the prosthesis **10** for its entire length. A slot **13** having a width somewhat less than the width and diameter of the opening **12** intersects the opening **12** and extends from the opening **12** to the outer surface of the prosthesis **10**. The cylindrical opening **12** and slot **13** combine to form a keyhole shaped opening which extends along the entire length of the prosthesis **10**.

The capitellar end **14** of the prosthesis **10** is somewhat rounded in configuration, but is preferably sharpened to provide a chisellike pointed edge **14***a* on the end of the prosthesis which is driven onto the bone. The outer articular surface of the prosthesis **10** is preferably polished to a mirror gloss or made as smooth as possible, so as to minimize friction. On the contrary, the inside surfaces of the opening **12** and slot **13** are preferably left unpolished to present somewhat rough surfaces which will increase the frictional engagement between these surfaces and the bone surfaces which they engage. The medial end **15** of the prosthesis **10** is preferably flat and is preferably polished or smooth.

The inside of the prosthesis **10** is provided with a concentric groove or keyway **16**, which extends along the lower or inner portion of the slot **13** and along the adjacent portion of the cylindrical opening **12**. The keyway **16** is disposed a short distance inwardly from the medial end **15** of the prosthesis **10**.

An elongated driver **17** is adapted to be used to mount the prosthesis **10** on the humerus. The driver **17** has an elongated preferably knurled handle portion **18** which is adapted to be manually grasped by the surgeon. The driver **17** has an inner end portion **19** of reduced diameter. The junction between the handle **18** and inner end portion **19** comprises a transversely directed shoulder **20** which is adapted to fit against and engage the medial end **15** of the prosthesis **10** when the driver **17** is in use.

The inner end portion **19** of the driver **17** is provided with a radially directed pin **21** which protrudes outwardly. The pin **21** has a pair of substantially parallel sidewalls which are dimensioned to fit within and engage the sidewalls of the keyway **16** in the prosthesis **10**.

The driver **17** is engaged with the prosthesis **10** by inserting the inner end **19** of the driver **17** into cylindrical opening **12** of the prosthesis **10**, with the pin **21** disposed within the slot **13**. The driver **17** is moved inwardly until its shoulder **20** engages the medial end **15** of the prosthesis **10**. The driver **17** is then rotated to move the pin **21** into the keyway **16**.

The operative technique for installing the prosthesis is as follows:

An incision is made over the medial humeral epicondyle and the ulna nerve is identified and retracted proximally. The ulnar collateral ligament is incised and the joint is thereby exposed. It is sometimes necessary to incise the lateral aspect of the joint as well as the medial. The joint is partially dislocated by traction on the forearm, so that both trochlea and capitellum may be visualized. The articular surface of the distal humerus is then chiseled away, using an osteotome, until the cross section of the distal humerus approximates that of the interior cross section of the prosthesis **10**, as shown in FIGS. **6** and **7** of the drawings.

The prosthesis, with the driver **17** attached, is then positioned medially to the reshaped distal humerus and gently hammered on in a lateral direction, as shown in FIG. **8** of the drawings. The sharpened capitellar side of the prosthesis acts like an osteotome, so that the prosthesis as it is driven on trims the bone to provide for a perfect fit. When the prosthesis **10** reaches the point where the inner end of the driver **17** engages or closely approaches the adjacent end of the humerus, the driver **17** is removed and the prosthesis **10** driven the remaining distance by hammering on the flat medial end **15** of the prosthesis **10**.

The ulnar collateral ligament is then reattached to the medial humeral epicondyle, the ulna nerve is released, and soft tissue closure is performed in the usual manner.

When the prosthesis is in place, as shown in FIG. **9** of the drawings, it is immovable and no pins or screws are required to maintain its position. It cannot move distally because the bone is thicker in the central opening **12** than in the slot **13**, and it cannot move laterally or medially because the roughly machined surfaces of the central opening **12** and slot **13** provide sufficient gripping engagement with the bone.

It will be noted that the distal humeral joint surface has thus been replaced by a relatively lightweight stainless steel, titanium or other articular surface. The new articular surface is held in place by interengagement between the prosthesis and the bone. Little bone has been removed, no muscle attachments have been cut, and generally only the ulnar collateral ligament and medial capsule have been incised.

The prosthesis is preferably made in seven standard sizes, which will fit substantially all adults. All of the seven sizes have exactly the same shape—they are only larger or smaller. A study of hundreds of elbows has indicated that while the size of the distal humerus varies, the shape is constant enough so that it is possible to develop a formula for the shape of the joint in which the only critical parameter is the width of the joint. The width of the joint is defined as the distance between the lateral side of the capitellum and the medial side of the trochlea. In other words, the present invention provides a universal distal humeral joint shape. Prostheses made to this one shape, of the appropriate size, will fit all joints well enough for adequate function.

The formula for this universal shape is:

Capitellar diameter (D_c) = 0.55
Trochlear diameter (D_t) = 0.55
Intracondylar ridge diameter (D_I) = 0.48
Minimum diameter (D_m) = 0.35
Lateral capitellum to intracondylar (L_I) = 0.55
Lateral capitellum to minimum diameter (L_m) = 0.70

Or:

$D_c = D_t = L_I = 0.55$
$D_c = D_t = D_I = 0.48$
$D_c = D_t = L_m = 0.70$
$D_c = D_t = D_m = 0.35$

FIG. **12** of the drawings shows the relationship between the above formula and the prosthesis **10**.

This formula is for the articular surface, not for the bony distal humerus as seen on X-ray. For any given width, the articular surface, and thus the prosthesis, will be of slightly greater diameter than the bone because the prosthesis must replace the cartilage on the humeral articular surface, which is approximately one-sixteenth of an inch thick.

As for the shape of the curved articular surfaces themselves, the capitellum is essentially a sphere, so that its cross section in any plane is a circle. The shape of the intracondylar ridge and of the curved surface between it and the trochlea are empirical and were developed to represent curvatures which would be compatible with substantially all elbows.

It is believed that seven standard sizes of prosthesis, varying in width in ⅛ inch steps between the limits of 1½ inch to 2¼ inch is the optimum number of sizes required for an adequate fit for substantially all adult elbows. For convenience in selecting the proper size of prosthesis, a phototemplate **30** may be provided which includes all of the sizes. The phototemplate **30** is shown in FIG. **10** of the drawings.

To determine the proper size to use, the orthopedic surgeon need only take a good antero-posterior X-ray of the elbow in question or the contralateral elbow of the same individual. The X-ray and phototemplate **30** are then superimposed and a comparison made to determine which size of prosthesis most closely approximates the X-ray. In using the phototemplate **30**, the surgeon should place the template curve midway between the humerus and the ulnar and radial bony surfaces on the X-ray. The template will then fall directly over the actual articular surface where the articular cartilages meet (see FIG. **11** of the drawings).

It may be noted that if the prosthesis **10** is not properly positioned when it is first mounted on the humerus, the engagement between the driver **17** and the prosthesis **10** which is provided by the pin **21** and keyway **16** provides a positive means for withdrawing the prosthesis **10** from the humerus so that it may be repositioned.

Once the prosthesis is in proper position, its keyhole type engagement with the bone prevents its displacement. The muscles and tendons in the surrounding area may also act to hold it against displacement.

FIG. **13** of the drawings shows another embodiment of prosthesis **40** in which a slot **41** is provided in the upper of the prosthesis, such slot **41** being of dovetail configuration in cross section. This type of prosthesis is particularly useful where a greater proportion of the humerus has been damaged or destroyed or must be removed to install the prosthesis.

It will be noted that all embodiments of the prosthesis are installed laterally or transversely across the end of the humerus and that the prosthesis is provided with a dovetail or type of engagement with the humerus which acts to prevent longitudinal displacement of the prosthesis. In the case of the distal humerus, the prosthesis may be driven on laterally or medially. In the case of other joints, the same or other transverse installation may be used.

In any embodiment of the invention, the prosthesis may, if desired, be provided with one or more holes for the purpose of removing material and thereby reducing the weight of the prosthesis.

In addition to being used as a distal humeral prosthesis, the present invention is capable of other endoprosthetic applications such as in the knee joint, ankle joint, etc. In such applications, the shape of the prosthesis is modified in an obvious manner as required for the particular bone upon which the prosthesis is mounted and its outer articular surface is modified to that of the articular surface which it replaces.

I claim:

1. A method of installing an osteoarticular prosthesis on the damaged end of a bone, said prosthesis being substantially cylindrical and having a longitudinal slot therein and an outer articular surface similar to the original articular surface of said damaged end of said bone, said method comprising shaping said damaged end of said bone to form a lateral cutaway portion shaped to accept said slot, mounting said prosthesis on said damaged end of said bone by positioning said prosthesis adjacent to one side of said damaged end of said bone with said slot aligned with said cutaway portion and then moving said prosthesis in a transverse direction across said damaged end of said bone from one side of said end of said bone to the other until said articular surface of said prosthesis assumes the position of the articular surface of said end of said bone, and securing said prosthesis against movement with respect to said end of said bone.

2. The method described in claim **1**, and securing said prosthesis fixed in said position on said end of said bone at the same time and by the same means by which said prosthesis is mounted on said bone.

3. The method described in claim **2**, said prosthesis having a keyhole-type opening therein to receive and hold the reshaped bone by interlocking engagement.

4. The method described in claim **3**, said keyhole-type opening having an open end at one end of said prosthesis, and driving said end of said prosthesis onto said bone so that said bone enters said opening through said open end.

5. The method described in claim **4**, said open end of said prosthesis having a cutting edge, and trimming said bone with said edge as said prosthesis is mounted on said bone.

6. The method described in claim **4**, said prosthesis having an internal keyway intersecting said opening and mounting said prosthesis on said bone with a driver having means adapted to engage said keyway.

7. The method described in claim **6**, and driving said prosthesis laterally onto the distal humerus.

8. The method described in claim **3**, and driving said prosthesis laterally onto the distal humerus.

9. The method described in claim **1**, and providing a limited number of standard sizes of said prosthesis, all of which have articular surfaces of substantially similar configuration except for differences in size, one of said standard sizes being usable for substantially any adult.

10. The method described in claim **9**, and determining the particular standard size of prosthesis to be used by a visual comparison of an X-ray of the contour of th the articular surface being replaced with a transparent phototemplate showing the articular surface of said standard sizes of said prostheses.