A humeral prosthesis features improved anatomic attachment areas for tendon or bone. In the preferred embodiment, in contrast to existing devices, at least one set of tendon/bone attachment points are provided along a line, at least a portion of which is divergent with respect to the axis of the stem. One or more sets of attachment points may be further be provided along a line which is substantially parallel to the axis of the stem, resulting in a “T” “L” or “U” shape. Alternatively, attachment points having a changing degree of diversion with respect to the axis of the stem may be provided along a common, curved line. The attachment points may simply be apertures formed through the body of the implant though, in the preferred embodiment, the apertures are provided on raised tabs. An area of bone-ingrowth material may be provided adjacent the attachment points, and may include a separate fastening mechanism such as a threaded hole to receive a screw. A groove may also be provided in any embodiment to receive the biceps tendon. Particularly with respect to fractures, including multi- and ‘four-part’ fractures, means specifically intended for the rigid reattachment of the greater or lesser tuberosities may be provided separately or in conjunction with other sets of reattachment configurations.
Fig - 1A

(PRIOR ART - USP #5,282,865)
SHOULDER PROSTHESIS WITH ANATOMIC REATTACHMENT FEATURES

FIELD OF THE INVENTION

[0001] This invention relates generally to orthopedic surgery and, in particular, to improved shoulder prostheses featuring more anatomic rotator cuff attachment geometries facilitating enhanced fixation of tendon and/or bone.

BACKGROUND OF THE INVENTION

[0002] A typical proximal humeral prosthesis is depicted generally at 100 in FIG. 1, this particular drawing being taken in part from U.S. Pat. No. 5,282,865. The device includes a modular head attachment 106, though variations of such devices exist, including those without modularity, and designs incorporating different modular arrangements.

[0003] A tab 102 is provided on the lateral side of the prosthesis, as shown. The tab 104 is provided with two or more holes 106 disposed parallel to the length of the prosthesis; that is, parallel to the axis 108 of the stem 110. Although the stated purpose of the apertured tab 102 is to assist with installation of the device and to minimize rotation once installed, it is common practice in repairing a fracture to bring previously detached tendons together and suture them to this vertical tab on the lateral side of the prosthesis.

[0004] The tendons which are detached during the procedure may include the subscapularis tendon, the supraspinatus tendon, the infraspinatus tendon, and the teres minor tendon, the anatomy of each being well known, particularly to orthopedic surgeons. Since, in the case of a natural humerus, these tendons attach at different points of the bone to perform specific functions, vertically oriented tabs such as tab 102 in FIG. 1 does not adequately accommodate human anatomy.

[0005] More particularly, existing configurations are acceptable only with respect to the attachment of the posterior and anterior tendons. Since the supraspinatus tendon naturally lies flat along the top surface of the bone, the use of a vertical tab leads to an orientation which is perpendicular to the desired attachment configuration. This result, being anatomically incorrect, typically results in a reduced range of motion and strength following the procedure, particularly in initiating abduction; that is, in raising that arm. This is especially true in proximal humerus fractures known as ‘four-part’ fractures involving the head, shaft, greater tuberosity, and lesser tuberosity. Re-attachment to a vertical fin with sutures results in poor fixation in a non-anatomic arrangement.

SUMMARY OF THE INVENTION

[0006] The subject invention resides in a humeral prosthesis with improved anatomic attachment areas for tendon or bone. As in prior-art devices, the invention includes an elongated body having a proximal end and a distal end terminating in a stem with an axis configured for placement within an intramedullary canal of a humerus. In the preferred embodiment of the invention, however, and in contrast to existing devices, at least one set of tendon/bone attachment points are provided along a line, at least a portion of which is divergent with respect to the axis of the stem.

[0007] One or more sets of attachment points may further be provided along a line which is substantially parallel to the axis of the stem, resulting in a “T,”“U” or “L” configuration, including inverted versions thereof. Alternatively, attachment points having a changing degree of diversion with respect to the axis of the stem may be provided along a common, curved line. The attachment points may simply be apertures formed through the body of the implant though, in the preferred embodiment, the apertures are provided on raised tabs. An area of bone-ingrowth material may be provided adjacent to or at the attachment site, and may include a separate fastening mechanism such as a threaded hole to receive a screw, or any other alternative means operable to rigidly attach the tendon or bone to the prosthesis. A groove may also be provided in any embodiment to receive the biceps tendon. In addition, a recess may be provided to accept a tendon-bone unit such as the greater or lesser tuberosities with their respective tendons attached. Particularly with respect to fractures, including multiaxial and ‘four-part’ fractures, means specifically intended for the rigid reattachment of the greater or lesser tuberosities may be provided separately or in conjunction with other sets of reattachment configurations.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] FIG. 1A is a drawing of a prior-art humeral prosthesis;

[0009] FIG. 1B is a drawing of proximal humerus and anatomic tendon attachments;

[0010] FIG. 1C is a drawing of a four-part fracture to which the subject invention is applicable;

[0011] FIG. 2A is a lateral view of a humeral prosthesis according to the invention having an inverted-U bone/tendon attachment configuration;

[0012] FIG. 2B is a lateral view of a humeral prosthesis according to the invention having a non-inverted-U bone/tendon attachment configuration;

[0013] FIG. 2C is a lateral view of a humeral prosthesis according to the invention having an inverted L-shaped bone/tendon attachment configuration;

[0014] FIG. 2D is a lateral view of a humeral prosthesis according to the invention having a T-shaped bone/tendon attachment configuration;

[0015] FIG. 3 is an alternative embodiment of the invention, wherein a plurality of attachment points are arranged along a common curved line;

[0016] FIG. 4 illustrates how bone-ingrowth sections are provided as localized sites along with fastening means to hold bone/tendon pieces in place; and

[0017] FIG. 5 is a drawing which shows a bone-ingrowth areas provided for greater and lesser tuberosities in conjunction with separate sets of suture points.

DETAILED DESCRIPTION OF THE INVENTION

[0018] As discussed above, this invention is directed to humeral prostheses providing more anatomical attachment configurations for bone and/or tendons, with the goal being a greater range of post-operative motion and/or strength. Before discussing the various embodiments of the invention
in detail, it will be helpful to introduce aspects of the anatomy associated with procedures contemplated herein.

[0019] FIG. 1B is a drawing of a human proximal humerus showing the natural anatomic tendon attachment areas. The humerus, 120, includes a proximal portion having a head 122 with an articulating surface adapted to co-act with the glenoid bone 126 in the shoulder joint. The supraspinatus tendon 130 lies flat on the proximal humerus, and attaches at a section of bone called the greater tuberosity 132. The subscapularis tendon 140 extends across the side of the joint and attaches at the lesser tuberosity 142. A groove 144 receives the biceps tendon (not shown).

[0020] FIG. 1C is a drawing which illustrates what typically occurs during a multi-part fracture of the proximal humerus, in the case a so-called four-part fracture to which the subject invention is applicable. In particular, the bone shatters, leaving a separate head and shaft portion 150 and 152. In addition, the greater tuberosity 160 breaks off with the supraspinatus tendon attached thereto. The lesser tuberosity 162 also forms a separate piece with the subscapularis tendon attached to that piece, as shown. The infraspinatus and teres minor tendons may be attached to the greater tuberosity as well or to separate fragments.

[0021] Reference is now made to FIG. 2A, which is a lateral view of a humeral prosthesis according to the invention. Broadly, an anterior-to-posterior feature such as tab 202 is provided for attachment of the supraspinatus. Although tab 202 is shown generally transverse to the axis of the implant, the invention anticipates other orientations, described herein, with the basic premise being that one or more sets of divergent attachment points are provided for a more anatomical compliance with the rotator cuff. By ‘diver
gen,’ it is meant that the set of connection points tend away from a line strictly parallel to the axis of the implant which, of course, would include one or more connectors which are transverse or perpendicular to the axis of the implant, regardless of the muscular attachments.

[0022] Having provided this facility, other tabs or attachment mechanisms be added for the anterior and/or posterior tendons, resulting in the preferred inverted “U” shape of FIG. 2A. An inverted-U is not the only tab configuration providing a more anatomic bone/tendon attachment arrangement according to the invention. As shown in FIG. 2B, a non-inverted-U bone/tendon attachment configuration may alternatively be provided, or an inverted L-shaped bone/tendon attachment configuration (FIG. 2C). As a further alternative, both anterior and posterior tendons may be attached to a single substantially vertical feature, with the result being a “T” shape, as shown in FIG. 2D. Other geometries are also possible, including non-inverted and rotated L and T shapes, as long as separate and distinct regions are provided for reattachment of the greater and lesser tuberosities.

[0023] Note also that separate tab segments need not be used, in that one or more curved features may be provided, preferably with tangents 304 and 306 substantially along the axis of the implant and transverse thereto, as shown in FIG. 3. To enhance reattachment, one or more of the tabs or other features may be coated with a bone-ingrowth material or bone-ongrowth material. Biologic enhancements such as hydroxyapatite may also be provided. As a further alternative, as shown in FIG. 4, bone-ingrowth sections may be provided as localized areas 405, along with fasteners such as screws 410 to hold the bone/tendon pieces in place. In this and each of the embodiments described herein, a groove 412 may be provided in the head and/or side portions of the prosthesis to receive the biceps tendon.

[0024] The areas of bone-ingrowth material may be provided along with, or apart from, the tabs or other reattachment facilities discussed elsewhere herein. For example, as shown in FIG. 5, a bone-ingrowth area 502 for lesser tuberosity may be provided in conjunction with suture holes 504, and/or ingrowth area 512 may be provided for greater tuberosity in conjunction with suture holes 514. Note that the suture holes need not be provided on a raised tab, but may be located along a ridge or depression, as convenient to the embodiment. In all embodiments, the invention is compatible with modular head/neck attachments as discussed in the Background of the Invention. FIG. 5, for example, shows a post 530 associated with a modular head attachment. The groove 520 is optionally be provided to receive the biceps tendon, as discussed above.

I claim:

1. A humeral prosthesis with anatomic tendon or bone reattachment features, comprising:

an elongated body having a proximal end and a distal end terminating in a stem with an axis, the stem being configured for placement within an intramedullary canal of a humerus such that a portion of the proximal end remains exposed; and

a set of tendon or bone reattachment points on the exposed portion of the proximal end, the points being arranged along a line, wherein at least a portion of the line is divergent relative to the axis of the stem.

2. The prosthesis of claim 1, further including at least one set of attachment points arranged along a line which is substantially parallel to the axis of the stem.

3. The prosthesis of claim 2, wherein the set of divergent attachment points and those arranged along a line which is substantially parallel to the axis of the stem form a “T” shape.

4. The prosthesis of claim 2, wherein the set of divergent attachment points and those arranged along a line which is substantially parallel to the axis of the stem forms an upright or inverted, forward or backward “L” shape.

5. The prosthesis of claim 2, wherein the set of divergent attachment points and those arranged along a line which is substantially parallel to the axis of the stem both lie along the same curved line.

6. The prosthesis of claim 1, further including two sets of attachment points, each arranged along a separate line which is substantially parallel to the axis of the stem.

7. The prosthesis of claim 6, wherein the set of divergent attachment points and those arranged along a line which is substantially parallel to the axis of the stem form an upright or inverted “U” shape.

8. The prosthesis of claim 6, wherein the set of divergent attachment points and those arranged along the two lines which are substantially parallel to the axis of the stem all lie along the same curved line.

9. The prosthesis of claim 1, where at least some of the attachment points are disposed on a raised tab.
10. The prosthesis of claim 1, further including an area of bone-ingrowth material adjacent to the set of attachment points.

11. The prosthesis of claim 1, further including a groove to receive a biceps tendon.

12. The prosthesis of claim 1, wherein the set of attachment points is arranged along a line which is substantially perpendicular to the axis of the stem.

13. The prosthesis of claim 1, wherein:

the bone to be attached includes the greater or lesser tuberosity; and

the prosthesis further includes a feature specifically intended to reattach the greater or lesser tuberosity.

14. The prosthesis of claim 13, wherein:

the feature specifically intended to reattach greater or lesser tuberosity includes a fastener-receiving aperture.

15. The prosthesis of claim 13, wherein:

the feature specifically intended to reattach greater or lesser tuberosity includes a bone-ingrowth surface.

16. The prosthesis of claim 13, wherein:

the feature specifically intended to reattach greater or lesser tuberosity includes a recess.

17. A prosthesis applicable to fractures of the humerus, including multi-part fractures wherein the greater or lesser tuberosities require reattachment, the prosthesis comprising:

an elongated body having a proximal end and a distal end terminating in a stem configured for placement within an intramedullary canal of a humerus, such that a portion of the proximal end remains exposed following installation; and

one or more features on the exposed portion of the proximal end, the position of each feature being specifically intended for the reattachment of one of the greater or lesser tuberosities.

18. The prosthesis of claim 17, wherein:

the feature specifically intended for the reattachment of the greater or lesser tuberosity includes a fastener-receiving aperture.

19. The prosthesis of claim 17, wherein:

the feature specifically intended for the reattachment of the greater or lesser tuberosity includes a bone-ingrowth surface.

20. The prosthesis of claim 17, wherein:

the feature specifically intended for the reattachment of the greater or lesser tuberosity includes a recess.

21. The prosthesis of claim 17, wherein two separate distinct regions are provided for reattachment of the greater and lesser tuberosities, respectively.

22. The prosthesis of claim 21, wherein the distinct regions include a bone ingrowth or ongrowth surface.

23. The prosthesis of claim 22, wherein the bone ingrowth or ongrowth surfaces include a biologic enhancement material.