
Abstract: Disclosed is a curved wall fastener, the fastener comprising a curved wall surrounding an axial bore, the curved wall having a first end, a second end and a central portion connecting the first end and the second end, and a shaft configured to be pressed into the axial bore and cause at least a portion of the curved wall to move radially outward, wherein the curved wall is configured to remain at a fixed angle with respect to a longitudinal axis of the axial bore during the radially outward movement.
CURVED WALL FASTENERS

RELATED APPLICATIONS
This application takes priority from US Provisional Applications 60/786,369 "Expanding Curved walled Fastener" filed 24 March 2006; and 60/802508 "Compact Tube Fastener" filed 07 May 2006, the content of which are incorporated by reference as if fully set forth herein.

FIELD AND BACKGROUND OF THE INVENTION
The present invention generally relates to fasteners having at least one curved wall portion that moves radially to secure in vivo tissue.

Soft Tissue Reconstruction
Reconstruction of soft tissue that has detached from the bone, for example a ligament or tendon, often entails securing a portion of the soft tissue to the bone with a fastener.

One well-known fastener comprises a screw and washer combination in which the soft tissue is placed under the washer and the screw is rotated into the bone. The washer linearly compresses the soft tissue against the bone while protecting the soft tissue from damage by the rotation of the screw. A drawback is that the screw head and washer provide considerable bulk above the bone surface and often cause irritation that may lead to skin ulceration.

Tack fasteners comprise a shaft that is expanded radially outward to secure within a bore in the bone, contacting the soft tissue directly without the interposition of a bulky washer. Tack fasteners are suitable for use: 1) where there is a moderate amount of tissue to cushion the overlying skin and 2) when deployed distant to a joint where the head might impinge on joint movement.

Mini anchors are headless soft tissue fasteners comprising a shaft that is anchored in the bone to which soft tissue is secured with suture. As the soft tissue is not compressed against, but merely tied against the bone surface, the resulting union
is generally weak, limiting the use of mini anchors to fastening smaller ligaments and tendons that are subject to low stress.

In addition, mini anchors comprising a shaft surrounded by a stretchable curved wall, in U.S. Patent 5,268,001 (Nichelson et al), foster movement between the soft tissue and bone that further weaken the bone-soft tissue union.

Knee ligaments, for example the Anterior Cruciate Ligament, (ACL) are subject to high stress, particularly during athletic activity, and require a high strength union between graft and bone. Reconstruction of the ACL typically comprises drilling a tunnel through the bones of the knee, placing a soft tissue graft within the tunnel and securing the graft with a fastener on each side of the knee joint.

One fastener used in securing an ACL graft, the interference screw, comprises a headless screw placed parallel to the graft in the tunnel of the tibia and/or femur that compresses the graft radially outward against the tunnel wall. Proper location of the interference screw within the tunnel can result in precision joint function. Additionally, compression of the graft against the bone within the tunnel results in a strong union.

A drawback of the interference screw is that while pushing and rotating the screw into place, the screw threads cut the graft, resulting in a weak graft that may tear during sport activities.

A curved walled interference screw, the BioFix™ by Johnson and Johnson, comprises a cone-shaped curved wall that surrounds a screw to protect the graft from damage by the screw threads. However, the curved wall includes a flange that prevents the fastener from being deployed at an optimal location near the joint space.

Joint Prostheses

Joint prostheses typically have stems that are placed in a bore in the bone to provide support for the prosthetic piece. Bone-to-graft contact, however, is often inadequate due to lack of radial outward compression by the prosthetic stem.

U.S. Patent Applications 20060194171; and 20050042574 (Lazarof), the content of which are incorporated by reference as if fully set forth herein, teach prosthetic tooth anchors having curved walls that split and radially expand and
provide anchoring of the prosthetic stem in the bore in the bone. The resultant curved wall walls, though, provide uneven pressure on the tissue within the bore.

**Intramedullary Nails**

Typical intramedullary (IM) rods do not expand in a manner that allows the rod to capture substantial portions of bone on either side of a fracture at the femoral isthmus; thereby often failing to prevent torque between the bone portions.

Cross pins in conjunction with IM rods are often placed at either end of the IM rod to prevent torque, as seen for example in U.S. Patent Application 20050069397 (Shavit, et al), the content of which is incorporated by reference as if fully set forth herein. However, cross pins require additional incisions and complex aiming instrumentation.

**Spinal Applications**

To prevent impingement of nerves exiting the spinal column, a dynamic stabilization device is positioned to lift the posterior portion of adjacent spinal vertebrae, as seen in 20060282079 (Labrom et al), the content of which is incorporated by reference as if fully set forth herein. However, significant dissection is required in order to insert such dynamic stabilization devices.

There is thus a widely recognized need for tissue fixation devices that are devoid of the above limitations.

**SUMMARY OF THE INVENTION**

The present invention successfully addresses at least some of the shortcomings of the prior art by providing a curved wall fastener comprising a curved wall having an axial channel including at least one fold and an elongate shaft insertable into the axial channel to cause radially outward movement of the curved wall.

In the pre-deployed configuration the curved wall is substantially easily inserted into the bone without causing damage to the soft tissue and allows soft tissue positional adjustments, for example longitudinal pulling that increases soft tissue tension.
In embodiments, the curved wall includes surface projections which, following radial expansion, substantially secure the soft tissue within the bore.

In further embodiments a forward end of the fastener moves radially outward to create a bore indentation that substantially prevents the fastener from being pulled toward the joint space as a result of graft forces generated during range of motion.

According to another aspect of the invention, there is provided a curved wall fastener, the fastener comprising a curved wall surrounding an axial bore, the curved wall having a first end, a second end and a central portion connecting the first end and the second end, and a shaft configured to be pressed into the axial bore and cause at least a portion of the curved wall to move radially outward, wherein the curved wall is configured to remain at a fixed angle with respect to a longitudinal axis of the axial bore during the radially outward movement.

In embodiments, prior to the radially outward movement at least a portion of an outer surface of the curved wall is substantially parallel to the longitudinal axis of the axial bore.

In embodiments, following the radial outward movement, at least a portion of an outer surface of the curved wall is substantially parallel to the longitudinal axis of the axial bore.

In embodiments, the curved wall is configured to maintain a fixed angle during the radially outward movement.

In embodiments, the curved wall is substantially radially continuous around the axial bore.

In embodiments, the curved wall is curvilinear. In embodiments, the curved wall is polygonal. In embodiments, prior to the radial movement, a first end of the curved wall overlaps a second end of the curved wall.

In embodiments, following the radial movement, the first end is substantially radially aligned with the second end.

In embodiments, the shaft comprises a first shaft configured to be pressed against the first end of the curved wall, and the fastener includes a second shaft configured to be pressed against the second end of the curved wall.

In embodiments, the first shaft includes a longitudinal axial guide bore.
In embodiments, the second shaft includes an elongate guide element, configured to slidingly pass through the longitudinal axial guide bore in the second shaft.

According to another aspect of the invention, there is provided a curved wall fastener, comprising: an elongate shaft, a rearward pointing conus juxtaposed along a rearward portion of the shaft, at least one curved wall surrounding at least a portion of the elongate shaft, the curved wall having a rearward edge aligned with a forward surface of the conus, and a cam nut moveably set along a forward portion of the shaft and aligned with a forward edge of the at least one curved wall, the cam nut configured cam against, and cause radially outward movement of the at least one curved wall.

In embodiments, the rearward shaft portion of the shaft includes a flare nut configured to interface with the rearward edge of the at least one curved wall.

According to a further aspect of the invention, there is provided a curved wall fastener, comprising: a shaft having two portions, a forward portion and a rearward portion, the rearward shaft portion having a flare, a linearly moveable nut slidingly disposed on the forward portion of the shaft, at least one elongate curved wall member juxtaposed along the shaft and adapted to move radially outward with respect to the curved wall as the nut moves toward the flare.

In embodiments, the linearly moveable nut comprises a ratchet nut and wherein at least a portion of the shaft includes ratchets configured to receive a ratchet projection from the ratchet nut.

In embodiments, the linearly moveable nut comprises a threaded nut and wherein at least a portion of the shaft is reciprocally threaded to the threaded nut.

According to a still further aspect of the invention, there is provided a sliding nut, comprising: an elongate threaded shaft, a nut comprising a body having an axial bore that is partially reciprocally threaded to the threaded shaft, and a smooth bore at an oblique angle to the axial bore, the smooth bore connected to the axial bore by a passage, the smooth bore and passage being configured to allow linear and pivoting movement of the elongate threaded shaft.
In embodiments, the fastener includes a tube having inner smooth walls axially disposed around the threaded shaft, the tube configured to slidingly received the sliding nut.

According to still another aspect of the invention, there is provided a method for compressing a bore in a tissue, the method comprising: boring a bore through a surface of an *in vivo* tissue, providing a curved wall having an axial bore and at least one fold along the wall, positioning the curved wall below the surface of the tissue, stabilizing the curved wall, pressing a shaft into the axial bore, causing at least a portion of the curved wall to move radially outward and press against at least a portion of the bore.

Unless otherwise defined, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. Although methods and materials similar or equivalent to those described herein can be used in the practice or testing of the present invention, suitable methods and materials are described below. In case of conflict, the patent specification, including definitions, will control. In addition, the materials, methods, and examples are illustrative only and not intended to be limiting.

**BRIEF DESCRIPTION OF THE DRAWINGS**

The invention of a fastener having curved walls is herein described, by way of example only, with reference to the accompanying drawings. With specific reference now to the drawings in detail, it is stressed that the particulars shown are by way of example and for purposes of illustrative discussion of the preferred embodiments of the present invention only, and are presented in the cause of providing what is believed to be the most useful and readily understood description of the principles and conceptual aspects of the invention. In this regard, no attempt is made to show structural details of the invention in more detail than is necessary for a fundamental understanding of the invention, the description taken with the drawings making apparent to those skilled in the art how the several forms of the invention may be embodied in practice.
In the drawings:

Figures IA-IB show a perspective and cross sectional view of a curved wall fastener, in accordance with embodiments of the present invention;

Figure 2 shows a shaft configured for use in conjunction with the curved wall shown in Figure IA, in accordance with embodiments of the present invention;

Figures 3-4B show deployment of a curved wall fastener, in accordance with embodiments of the present invention;

Figures 5-9 show the fastener of Figure 4B configured for, and being deployed in, a cross section of a knee, in accordance with embodiments of the present invention;

Figure 10 shows a curved wall fastener configured for fastening a bone portion being deployed in a cross section of a knee, in accordance with embodiments of the present invention;

Figures 11A-IIB show the parts of a curved wall fastener having dual flanges, in accordance with embodiments of the present invention;

Figure 12 shows parts of the curved wall fastener of Figures 11A-IIB assembled and being deployed in a spinal portion, in accordance with embodiments of the present invention;

Figure 13 shows a prior art fastening system deployed in an elbow;

Figures 14-17 show curved wall fastener configured for, and being deployed in, a variety of in vivo environments, in accordance with embodiments of the present invention;

Figures 18A shows a curved wall fastener having a cross pin, in accordance with embodiments of the present invention;

Figures 18B shows a curved wall fastener having a release mechanism, in accordance with embodiments of the present invention;

Figures 19A-19C show the curved wall fastener of Figure 18A with a key slot and being deployed in a cross section of bone, in accordance with embodiments of the present invention;

Figure 20 shows the fastener of Figure 19A having dual shafts and being deployed in a cross section of bone, in accordance with embodiments of the present invention;
Figures 21A-21B show the fastener of Figure 20 having an integral guide wire, in accordance with embodiments of the present invention;

Figure 21C shows the fastener of Figure 21B being deployed in a cross section of a knee, in accordance with embodiments of the present invention;

Figure 22-24 show exploded and assembled views of a dual curved wall fastener, in accordance with embodiments of the present invention;

Figure 25 shows the fastener of Figure 24 in a cross section of the upper femur, in conjunction with femoral head prosthesis, in accordance with embodiments of the present invention;

Figure 26 shows a slide nut in cross section, in accordance with embodiments of the present invention;

Figure 27-28 show the slide nut of Figure 26 installed in a cross section of the femur, in accordance with embodiments of the present invention; and

Figures 29-30 show the fastener of Figures 21A and 21B configured with a spiral curved wall and ratchet nut, in accordance with embodiments of the present invention.

**DESCRIPTION OF THE PREFERRED EMBODIMENTS**

The present invention is an orthopedic fastener having a curved wall that moves radially outward in *in vivo* tissue.

The principles and operation of a curved wall fastener according to the present invention may be better understood with reference to the drawings and accompanying descriptions.

Before explaining at least one embodiment of the invention in detail, it is to be understood that the invention is not limited in its application to the details of construction and the arrangement of the components set forth in the following description or illustrated in the drawings. The invention is capable of other embodiments or of being practiced or carried out in various ways. Further, it is to be understood that the invention is not limited in its application to the details set forth in the following description or exemplified by the Examples. The invention is capable of other embodiments or of being practiced or carried out in various ways. Also, it is to
be understood that the phraseology and terminology employed herein is for the purpose of description and should not be regarded as limiting.

Referring now to the drawings, Figures 1A and 1B show perspective and cross sectional views of a curved wall 150 having an axial bore 156 and a cam edge 152. Curved wall 150 is shown in a pre-deployed configuration and, optionally, formed into a four sided curvilinear configuration including walls 159 that join at a fold 157.

While fold 157 is shown substantially parallel to a longitudinal axis of a curved wall fastener 100, fold 157 is optionally positioned anywhere between zero degrees and 80 degrees to the longitudinal axis of fastener 100.

A shaft 140 having an axial guide channel 125 and securing tabs 139 is shown in Figure 2.

Figure 3 shows a cross sectional view of curved wall 150 comprising upper slits 143 and a thickened first end 145 that in combination radially move with respect to a monotonous inner curved wall portion 147 to form a conus, as will be seen below.

To deploy fastener 100, securing tabs 139 are compressed radially inward and shaft 140 is pressed in an upward and proximal direction 108 so that a shaft cam surface 142 cams against cam edge 152.

As used herein, the terms proximal and proximally refer to positions and movement respectively deeper into bore 114 toward femur 360. As used herein, the terms distal and distally refer to positions and movement respectively outward from bore 114 in the body.

While curved wall fastener 100 comprises a four-sided polygon shape, other non-limiting shapes of curved wall 150 will be shown; the shape and configuration of curved wall 150 being well-known to those familiar with the art.

Continued pressure from cam surface 142 on cam edge 152 causes curved wall axial bore 156 to open and allow a shaft support surface 148 to enter axial bore 156.

Figure 4A shows a cross section of shaft 140 within axial bore 156 wherein fold 157 has unfolded and walls 159 have moved radially outward to form a substantially tubular round configuration.

Additionally, slits 143 have opened while thickened first edges 145 have been pushed radially outward by the pressure from shaft 140, thereby forming a conus.
Thickened first edge 145 provides anchoring within soft trabecular bone as will be explained below.

As seen in Figure 4B, rib clefts 149 have opened, allowing outward tissue securing projections 149 to assume a substantially circular configuration.

In the embodiment shown, rows of outward projections 149 comprise ribs. In other embodiments, securing projections 149 comprise rows of outwardly disposed conical projections.

In the embodiment shown, rows of outward projections 149 are substantially perpendicular to the longitudinal axis of said fastener. In other embodiments, rows of outward projections 149 are between 90 degrees and 170 degrees to longitudinal axis of said fastener; the many configurations and angles of outward projections 149 being well-known to those familiar with the art.

The in vivo deployment of curved walled fastener 100 is facilitated with one or more ancillary devices. Referring to Figures 5-7, curved wall fastener 100 includes a guide wire 130 having a transverse bar 131. Transverse bar 131 optionally includes a transverse slot 133 that slides around guide wire 130, to position transverse bar under a retaining head 171.

Figure 8 shows a cross section of a knee joint 322. Graft strands 390 extend from a femur 360 and are pressed radially outward against a portion of trabecular bone 112 within a tibia 350. Fastener 100 is typically inserted in the collapsed configuration between graft strands 390.

In embodiments, few sutures are required in forming graft strands 390 into a construct that is appropriate for knee 322. The reduced number of sutures substantially potentially reduces the time required for the graft preparation during the surgical procedure; an advantage for surgeons and operating rooms.

Additionally, grafts grown ex vivo from stem cells are taught by Altaian, et al in U.S. Patent 6,217,340, the disclosure of which is incorporated herein in its entirety by reference. Stem cell grafts have the potential to avert pain and/or deficit in motion often associated with harvesting graft tissue from the patient.

Appropriate tension, torque, and compressive forces on the growing grafts duplicate the forces on the native ACL, causing graft strands to develop appropriate
architecture ex vivo. These forces are optionally continued in vivo to ensure that graft strands 390 incorporate into the bone with appropriate histological architecture.

As seen in Figure 9, following radially outward movement, transverse bar 131 is freed of guide wire 103 and pulled in a side direction 129. When deployed in arthroscopic procedures, transverse bar 131 is optionally accessed through a side portal 135; using instrumentation that are well known to those familiar with the art.

Following removal of transverse bar 131, guide wire 103 is pulled out of shaft 140 in a downward and distal direction 137.

Curved wall 150 and/or shaft 140 do not include a head that projects out to secure curved wall 150 to the surface of in vivo tissue 112 so that fastener 100 is optionally fully contained within bore 114.

In embodiments, curved wall 150 comprises a substantially non-compressible material, herein radially inelastic material, so that a substantial portion of the radial outward forces provided by curved wall 150 are transferred against ligament strands 390 and/or in vivo tissue 112. Additionally or alternatively, curved wall 150 comprises a substantially longitudinally non-deforming material, herein longitudinally inelastic material, so that curved wall 150 substantially does not deform longitudinally during outward movement.

Curved wall 150 is compressed against ligament strands 390 substantially without forward or rearward translation of curved wall 150, so there is substantially minimal shear force that is transferred to ligament strands 390 during outward movement.

Additionally or alternatively, curved wall 150 is compressed against ligament strands 390 without rotational translation of curved wall 150, so there is substantially minimal cutting action of outward projections 149 into ligament strands 390 during outward movement.

**Bone Tendon Bone Grafts**

While curved wall fastener 100 has been shown in securing ligament strands 390 in knee 322, fastener 100 may be adapted for securing a variety of soft tissue portions of varied thicknesses to any bone in the body.
As an example with respect to knee 322, Figure 10 shows a graft fastener 400 configured for use with a bone tendon bone graft 416. Bone tendon bone graft 416 comprises a first bone portion 410 that installs in the upper knee bone; a second bone portion 418 that installs in tibia 350 (not shown); and a ligament portion 412 between bone portions 410 and 418.

In embodiments, a curved wall 424 comprises a substantially "c" shape cross section to partially encircle bone portion 410. Additionally, in embodiments cam portion 142 includes a substantially "c" shape cam edge 470, adapted to enter axial bore 156.

In further embodiments, curved wall 424 includes wide slots 401 that extend from the upper portion of fastener 400 and wide slots 403 that extend from the lower portion of fastener 400.

Wide slots 403 pass in between, and optionally parallel to, wide slots 401 in the center of curved wall 424. Wide slots 401 and 403 allow substantial flexibility in curving wall 424 into, and out of, the substantially "c" shape. Additionally, upon radial outward movement, wide slots 401 and 403 transfer significant radial pressure against bone portion 410.

In embodiments seen in Figure 11A, shaft 140 includes a conical second end 191. In embodiments seen in Figure HB, curved wall 424 includes lower wide slots 403 that move radially outward when containing conical second end 191.

A dynamic stabilizing fastener 850, shown in Figure 12, demonstrates shaft 140 and curved wall 424 of Figures H A and 11B respectively, assembled and used between spinal vertebrae 810.

### Spinal Applications

Dynamic stabilizing fastener 850 is configured for providing substantial bulk to separate vertebral processes 812, thereby separating vertebral bodies 810 and removing pressure from a nerve root 878.

Curved wall 424 includes lower slots 401 and upper slots 403 that open to form oblique portions which stabilize fastener 850 on either side of posterior processes 812.
Dynamic stabilizing fastener 850 inserts through a small incision in a compact configuration and then radially enlarged to provide substantial bulk with which to separate vertebral processes 812 with minimal dissection.

5 **Elbow Fastener**

Figure 13 shows a typical prior art "open reduction internal fixation" (ORIF) of an elbow fracture 968 in a radius bone 908, just below a humerus 938. The center of radius 908 is soft and does not support screws (not shown). Installing screws through a cortex 990 on either side of fracture 968 can cause damage within a joint space 942.

To provide proper fixation without damage to joint space 942, Kirschner wires 920 are driven across fracture 968. A monofilament wire 980 is then passed through drill holes 930 in cortex 990 and formed into a figure eight 930 that provides compression on fracture 968.

A major drawback of this prior art procedure is that considerable dissection is required to accommodate Kirschner wires 920 and monofilament wire 980; typically a "hockey stick" incision 960, perhaps 17 to 22 centimeters in length. Incision 960, unfortunately will likely heal with considerable scarring, impeding range of motion (ROM) of joint 948.

In distinct contrast, as shown in Figure 14, an elbow curved wall fastener 900 installs through a smaller incision 944, perhaps two centimeters in length, resulting in a small scar that will likely not impede elbow ROM.

Curved wall 150 is radially enlarged on one side of fracture 968 and secures against a wide area of bone between cortex 990 walls.

Shaft 140 passes through fracture 968 and is fitted with a nut 982 and a washer 910 that adjustably compress cortex 990, thereby compressing fracture 968.

**Prosthetic Stem**

Figure 15 shows a curved wall fastener 1100 in an embodiment as a stem for femoral prosthetic head 1190, including components of a femoral head 1160, a femoral neck 1152, a prosthetic platform 1154 that rests upon a cortical edge 1112.
and a nut 1182 that is rotated to secure a prosthetic stem 1184 on a post 1140 which is an extension of a shaft 140.

Curved wall 150 is compressed radially outward against a cortex 990; thereby spreading forces generated at femoral prosthetic head 1160 to a large surface area of cortex 990; which in turn helps maintain integrity of cortex 990 against the damage caused by focal pressures of a typical prosthetic stem (not shown).

**Intramedullary Rod**

Figure 16 shows a fracture 1138 through femur 360 with femoral fastener 1100 anchored against a cortex 990. Curved wall 150 provides substantial contact against bone portions on either side of fracture 1138, thereby aligning fracture 1138 and preventing torque.

**Mini Anchor**

Figure 17 shows a mini anchor fastener 500 for securing soft tissue 570 in a bone portion 512. Mini anchor fastener 500 is used, for example, when soft tissue 570 comprises a ligament that has ripped away from an attachment to a bone cortex 516. For embodiments, mini anchor fastener 500 in the pre-deployed configuration is configured to have a cross sectional area that is less than the cross sectional area of bore 114, thereby allowing placement of soft tissue 570 in bore 114 along with fastener 500.

To secure soft tissue 570, bore 114 is made through cortex 516 and optionally into trabecular bone 512. Fastener 500 is introduced into bore 114, along with soft tissue portion 570 so that a portion of soft tissue 570 passes through a portion of cortex 516.

Mini anchor fastener 500 is enlarged, optionally below a portion of cortex 516, thereby compressing soft tissue 570 against trabecular bone 512 where there are appropriate vascular channels to supply healing-promoting nutrients to soft tissue 570.

Additionally or alternatively, curved wall fastener 500 is radially enlarged against cortex 516 to compress, and therefore aid in securing soft tissue 570.
Following compression of soft tissue 570, a suture 510 is optionally passed through soft tissue 570 and tied, securing soft tissue 570 in bore 114, thereby providing further stability of soft tissue 570.

Curved wall 150 applies constant, even pressure throughout curved wall 150 interface with *in vivo* tissue 512 during movement and/or in the final configuration so that *in vivo* tissue 512 becomes substantially evenly compressed from one end to the other of contact area with curved wall 150. As a result, when bore 114 includes soft tissue 570, movement of nutrients and/or migration of *in vivo* cells from *in vivo* tissue 512 readily move to tissue 570, fostering a strong soft tissue/bone interface.

**Alternative Configurations**

Figure 18A shows a curved wall fastener 200 comprising two-sided smooth curved wall 150 in a pre-deployed configuration with respect to bore 114 in *in vivo* tissue 112.

To allow curved wall 150 to be easily placed in bore 114 in the pre-deployed configuration, curved wall 150 is optionally formed into a curvilinear configuration, allowing the circumference to reach maximum diameter upon radial outward movement.

In embodiments, guide wire 103 includes a transverse pin 122 that slides into a transverse pinhole 123. While transverse pin 122 is shown being slidingly attached to pin hole 123, pin 122 may be fixed to guide wire 103 and comprise any one of several radially outwardly projecting configurations, some non-limiting embodiments being described below.

To secure fastener 200 in bore 114, guide element 103 is pressed in an upward, proximal, direction 108 so transverse pin 122 contacts shaft 140 and presses shaft upward. As shaft 140 movement causes the upper portion of curved wall 150 to press and stabilize against upper surface 158 within *in vivo* tissue bore 114 and, with continued pressure, curved walled fastener 200 enlarges within bore 114 to secure tissue in bore 114.

Following radial outward movement of curved walled fastener 200, guide wire 103 is removed from a guide bore 125, for example by pulling guide wire 103 in a
distal direction 162. Alternatively, transverse pin 122 is pulled out of guide wire 103 and guide wire 103 is pulled out of shaft 140 in proximal direction 108.

Typically, curved wall 150 is enlarged radially against in vivo tissue 112 without forward or rearward translation of curved wall 150, so there is substantially minimal shear force that is transferred to in vivo tissue 112 during movement.

Figure 18B shows a curved wall fastener embodiment 300 including eyelet legs 172 and 174 having tines 182 and 184, respectively.

Upon movement of curved wall 150, tines 182 and 184 lock into curved wall tine receptacles 82 and 84 respectively, preventing movement of shaft 140 in curved wall 150.

To remove shaft 140 from curved wall 150, a tine cord 173 is pulled in direction 162 to cause legs 172 and 174 to move toward each other and release tines 182 and 184 from tine receptacles 82 and 84.

Optionally a tool 185 is used to stabilize curved wall 150 during removal of shaft 140.

Alternatively, legs 172 and 174 which extend beyond curved wall 150 when shaft 140 is contained within curved wall 150, are pressed toward each other using an instrument, for example a forceps (not shown), to facilitate removal of shaft 140 from bore 156.

Legs 172 and 174 allow an operator to remove fastener 300, for example for repositioning curved wall 150 and or retensioning graft strands 390 shown above. As the interface between surface of curved wall 150 and bore 114 is constant and non-threaded, removal of fastener 300, adjustment of fastener 300 positions, and further deployment of fastener 300, is optionally repeated without compromising the integrity of tissue 112.

Figure 19A shows an alternative curved wall fastener embodiment 180 in which shaft 140 has a longitudinal channel 119 and guide wire 103 has a radially outward extending end projection 121. In embodiments, sleeve 150 is positioned within bore 114. Guide wire 103 is pulled in distal direction 162 to cause end projection 121 to press on a shaft upper surface 199. A tool 163 is used to stabilize curved wall 150 and shaft 140 is pulled into sleeve 150 as end projection 121 is pulled in distal direction 162.
Following shaft 140 being pulled into curved wall 150, as seen in Figure 19B, guide wire 103 is rotated in a direction 127 to align end projection 121 with key channel 119. As seen in Figure 19C, guide wire 103 is pulled downward in distal direction 162. End projection 121 slides through key channel 119 and guide wire 103 is pulled out of shaft 140. Fastener embodiment 180 dispenses with the need to remove pin 122 separately from guide wire 103 (Figure 18A).

Figure 20 shows a curved walled fastener 160 having two shafts 140 and mounted on guide wire 103. Tool 163 is pushed in proximal direction 108 while guide wire 103 is pulled in distal direction 162, thereby causing the two shafts 140 to move toward each other within curved wall 150.

Tool 163 is optionally configured to press against pre-deployed curved wall 150 to aid in aligning two shafts 140 within curved wall 150. Following movement of curved wall 150, guide wire 103 is turned, so the projection aligns with channel 119, and is removed, as noted above.

Figure 21A shows an integrated guide fastener 240 having an elongate guide member 209 projection from a shaft 205 and passing through guide wire channel 119 in shaft 140.

During deployment, tool 163 is pressed against shaft 140 in direction 162 while guide member 209 is pulled in direction 108, causing shaft 140 to move in direction 108 and enter curved wall 150. Radial ledge 207 presses into cam edge 152, causing shaft 205 to enter curved wall 150.

Figure 21B shows integrated guide fastener 240 with curved walls 150 in a deployed configuration. Figure 21C shows integrated guide fastener 240 deployed in knee joint 322 with shaft 209 having been severed from fastener 240 using any one of several types of cutting tools.

Figure 22 shows a dual curved wall bolt 700 that includes a shaft 1194 having a threaded portion 1192, a square end 1156, and a flare end 1150. Curved walls 1140 include forward oblique surfaces 1142 and rearward oblique surfaces 1148.

A threaded securing nut 1120 having a bore 1160 with threads 1162 includes bevels 1122 that interface with forward oblique surfaces 1142. A flare nut 1116 includes a bore 1132 that encircles shaft 1194 and a flare cavity 1130 that encircles flare 1150. Beveled surfaces 1114 interface with rearward oblique surfaces 1148.
Figure 23 shows assembled fastener 700, in which threaded securing nut 1120 includes grasping flats 1164 for grasping with a stabilizing instrument (not shown). To cause radial outward movement, square end 1156 is rotated in a direction 270. By grasping flats 1164, threaded nut 1120 is stabilized against rotating and prevents curved walls 1140 and flare nut 1116 from rotating.

As shaft 1190 rotates in a direction 270, threaded securing nut 1120 moves linearly toward flared nut 1130. In an exemplary embodiment, nut 1130 remains stationary, while flare 1150 rotates.

In the pre-deployed configuration, central portions of curved walls 1140 into each other, herein interdigitation of side edges, to maximize the diameter of fastener 700 that is in contact with tissue in the radial outward position. Fastener 700 is seen in Figure 24 having curved walls 1140 in a radially outward position.

Figure 24 shows curved walls 1140 in radially outward positions. The interdigitation of central portions of curved walls 1140 maximize the diameter of fastener 700 that is in contact with tissue in the radial outward position. In this manner, ligaments 290 (Figure 21C), are more likely to be pressed against bone 350, rather than being positioned between curved walls 1140.

A partial ring 1198 of a flexible hard material, for example surgical spring steel, provides radial inward pressure against curved walls 1140 to maintain proximity to shaft 1194.

In an alternative embodiment, a ring (not shown) that completely surrounds dual curved wall fastener 700, for example manufactured from an elastomeric material, may be used in place of partial ring 1198.

Femoral Prosthetic Stem

Figure 25 shows dual curved wall fastener 700 installed in a cross section of upper femur 1910 and a femoral head 1190 being attached to shaft 1194. Prosthetic base 1185, for example, has inner threads that screw onto threads 1190. A securing screw 1193 is optionally provided and tightened to maintain alignment of prosthetic head 1160. The large surface area of compression surfaces of curved walls 1140 serve
to spread forces and substantially prevent resorption of cortex 990. For purposes of securing in bone 904 without the interposition of soft tissue noted above, walls 1140 optionally do not interdigitate, herein side edges of walls 1140 are smooth.

Slide Nut

Figures 26-27 show the operation of a slide nut 7000 that secures to threaded shaft 1193. Slide nut 7000 includes a body 6830 having a non-threaded passage 6814 whose diameter is larger than threaded shaft 1193 and a threaded passage 6822 having threads 6820 adapted to interface with shaft threads 1191. Threaded passage 6822 is connected to non-threaded passage 6814 by a tilt passage 6812.

In Figure 26, shaft 1193 is aligned with non-threaded passage 6814 so that nut 7000 slides linearly along shaft 1194 in a direction 6870 without rotating nut body 6830.

In Figure 27, nut body 6830 has been pivoted so that shaft 1194 passes through tilt passage 6812 and aligns with threaded passage 6822 and shaft threads 1191 interface with nut body threads 6820. Movement of nut body 6830 in direction 6870 occurs by rotation in a direction 6872. Nut body 6830 is rotated until body 6830 is substantially surrounded within a stabilizing cup 6880.

Stabilizing cup 6880 includes tabs 6882 and 6884 that secure to bone 910. Optionally, cup 6880 includes friction surface 6886 that interfaces with nut body 6830. Rotation counter to direction 6872 allows nut body 6830 to loosen.

Femoral Condyle Fixation

Figure 28 shows dual curved wall fastener 700 installed in a cross section of femur 6172 having fracture 922 near femoral condyles 912.

Nut 7000 provides compression force along fracture 922 that is adjusted by rotating nut body 6830 in direction 6872 or counter to direction 6872. Typically, shaft 1193 is cut flush with nut body 6830 and removed through a small incision 6822 that was used for insertion of fastener 700 and nut 7000.
Spiral Curved wall Fastener

Figure 29 shows a spiral curved wall fastener 1400 having a ratchet fastener 1800, a rearward flare 1430, and a spiral curved wall 1440.

As a ratchet nut 2710 moves toward flare 1430, a forward curved wall edge 1442 is pressed by forward nut surface 2732 and rearward curved wall edge 1444 is pressed by flare 1430, causing curved wall 1440 to move radially outward, until, as seen in Figure 30, curved wall 1440 is at a maximal diameter.

Materials

In embodiments, curved wall 150 and/or shaft 140 comprise a metallic base from the group consisting of: stainless steel, nitinol, tantalum, MP35N alloy, a cobalt-based alloy, a cobalt-chromium alloy, platinum, titanium, or other biocompatible metal alloys.

In embodiments, curved wall 150 comprises a material manufactured by a process from the group consisting of: interlacing knitting, interlocked knitting, braiding, interlacing, and/or dipping a porous mold into one or more reagents.

In embodiments, curved wall 150 and/or shaft 140 comprise a bio degradable / bio-absorbable base from the group consisting of: PGLA, PLLA, PLA, bio-resorbable magnesium, or other bio resorbable compounds.

In embodiments, curved wall 150 and/or shaft 140 comprise a material selected from the group consisting of: polyethylene, polyvinyl chloride, polyurethane, nylon and a biocompatible polymer fiber.

In embodiments, curved wall 150 and/or shaft 140 include an active pharmaceutical ingredient.

In embodiments, curved wall 150 and/or shaft 140 comprise a material selected from the group consisting of: synthetic biostable polymer, a natural polymer, and an inorganic material.

In embodiments, the biostable polymer comprises a material from the group consisting of: a polyolefin, a polyurethane, a fluorinated polyolefin, a chlorinated polyolefin, a polyamide, an acrylate polymer, an acrylamide polymer, a vinyl polymer, a polyacetal, a polycarbonate, a polyether, a polyester, an aromatic polyester, a polysulfone, and a silicone rubber.
In embodiments, the natural polymer comprises a material from the group consisting of: a polyolefin, a polyurethane, a Mylar, a silicone, and a fluorinated polyolefin.

In embodiments, curved wall 150 and/or shaft 140 comprise an alloy that includes tantalum, tungsten, and zirconium: tantalum from about 20% to about 40% by weight; tungsten from about 0.5% to about 9% by weight; and zirconium from about 0.5% to about 10% by weight.

In alternative embodiments, curved wall 150 and/or shaft 140 comprise an alloy such as nitinol (Nickel-Titanium alloy), having shape memory characteristics.

Shape memory alloys have super-elastic characteristics that allow curved wall 150 to be deformed during insertion. When curved wall 150 is exposed to the correct temperature conditions, the shape memory material returns to an original expanded configuration and maintains an inelastic configuration. Curved wall 150, for example, is superelastic in the range from at least about twenty-one degrees Centigrade to no more than about thirty-seven degrees Centigrade.

As used herein, a nitinol alloy refers to an alloy comprising between about at least 50.5 atomic percent Nickel to no more than about 60 atomic percent Nickel with the remainder of the alloy being Titanium. The term nitinol is intended to refer to a two-component memory metal stent discussed above as well as any other type of known memory metal stent.

It is expected that during the life of this patent many relevant curved wall orthopedic fasteners will be developed and the scope of the term curved walled fastener is intended to include all such new technologies apriori.

As used herein the term "about" refers to ± 10%.

It is appreciated that certain features of the invention, which are, for clarity, described in the context of separate embodiments, may also be provided in combination in a single embodiment. Conversely, various features of the invention, which are, for brevity, described in the context of a single embodiment, may also be provided separately or in any suitable subcombination.

Although the invention has been described in conjunction with specific embodiments thereof, it is evident that many alternatives, modifications, and variations
will be apparent to those skilled in the art. Accordingly, it is intended to embrace all such alternatives, modifications, and variations that fall within the spirit and broad scope of the appended claims. All publications, patents, and patent applications mentioned in this specification are herein incorporated in their entirety by reference into the specification, to the same extent as if each individual publication, patent or patent application was specifically and individually indicated to be incorporated herein by reference. In addition, citation or identification of any reference in this application shall not be construed as an admission that such reference is available as prior art to the present invention.
What is Claimed is:

1. A curved wall fastener, comprising:
   i) a curved wall at least partially surrounding an axial bore, said curved wall having a first end, a second end and a central portion connecting said first end and said second end; and
   ii) a shaft configured to be pressed into said axial bore and cause at least a portion of said curved wall to move radially outward, wherein at least a portion of said curved wall is configured to remain at a fixed angle with respect to a longitudinal axis of the axial bore during said radially outward movement.

2. The fastener according to claim 1, wherein at least a portion of said curved wall is substantially radially inelastic.

3. The fastener according to claim 1, wherein at least a portion of said curved wall is substantially longitudinally inelastic.

4. The fastener according to claim 1, wherein said curved wall includes at least two rows of outward projections.

5. The fastener according to claim 4, wherein said at least two rows of outward projections comprise at least two ribs that are substantially parallel to each other.

6. The fastener according to claim 4, wherein said at least two rows of outward projections are substantially perpendicular to the longitudinal axis of said fastener.
7. The fastener according to claim 4, wherein said at least two rows of outward projections are between 90 degrees and 170 degrees to longitudinal axis of said fastener.

8. The fastener according to claim 1, wherein prior to said radially outward movement at least a portion of an outer surface of said curved wall is substantially parallel to said longitudinal axis of said axial bore.

9. The fastener according to claim 1, wherein following said radial outward movement at least a portion of an outer surface of said curved wall is substantially parallel to said longitudinal axis of said axial bore.

10. The fastener according to claim 1, wherein in a radially outward position, a substantial portion of said curved wall is supported by said shaft.

11. The fastener according to claim 1, wherein at least a portion of an outer wall of said curved wall is configured to maintain a monotonous longitudinal configuration during said radially outward movement.

12. The fastener according to claim 1, wherein said curved wall comprises at least one fold substantially along a longitudinal axis of said fastener.

13. The fastener according to claim 1, wherein said curved wall comprises at least one fold angled at between zero degrees and 80 degrees to longitudinal axis of said fastener.

14. The fastener according to any of claims 12 and 13, wherein said at least one fold is positioned between a first portion of said curved wall and a second portion of said curved wall and said first and second portions are configured to move radially outward as said shaft is pressed into said axial bore.
15. The fastener according to claim 1, wherein said curved wall is substantially radially continuous around said axial bore.

16. The fastener according to claim 15, wherein said curved wall is curvilinear.

17. The fastener according to claim 15, wherein said curved wall is polygonal.

18. The fastener according to claim 1, wherein prior to said radial movement, a first end of said curved wall overlaps a second end of said curved wall.

19. The fastener according to claim 18, wherein following said radial movement, said first end is substantially radially aligned with said second end.

20. The fastener according to claim 1, wherein said first end of said curved wall is thickened such that when pressed by said first end of said shaft, the average diameter of the outer surface of said first end of said curved wall is greater than the average diameter of the outer surface of said central portion of said curved wall.

21. The fastener according to claim 20 wherein said first end of said curved wall comprises at least one first end slit having an opening that is configured to enlarge upon movement of said curved wall.

22. The fastener according to claim 21 wherein said at least one first end slit is substantially parallel to a longitudinal axis of said fastener.

23. The fastener according to claim 21 wherein said at least one first end slit is angled at between zero degrees and 80 degrees to a longitudinal axis of said fastener.
24. The fastener according to any one of claims 1 and 20, wherein said second end of said shaft has a greater diameter than said central portion of said shaft such that when pressed against the second end of said curved wall, the average diameter of the outer surface of said first end of said curved wall is greater than the average diameter of the outer surface of said central portion of said curved wall.

25. The fastener according to claim 24 wherein said second end of said curved wall comprises at least one second end slit having an opening that is configured to enlarge upon radial outward movement of said curved wall.

26. The fastener according to claim 25 wherein said at least one second end slit is substantially parallel to a longitudinal axis of said fastener.

27. The fastener according to claim 25 wherein said at least one second end slit is angled at between zero degrees and 80 degrees to a longitudinal axis of said fastener.

28. The fastener according to claim 1, including at least two first end slots extending from said central portion to said first end and at least one second end slot extending from said central portion to said second end, wherein at least a portion of said at least one second end slot passes between and is spaced a distance from said at least two first end slots.

29. The fastener according to claim 28, wherein at least a portion of said at least two first end slots are parallel to at least a portion of at least one second end slot.

30. The fastener according to claim 1, wherein said first end of said shaft includes a projection configured to contact said first end of said curved wall and maintain said shaft within said axial bore.

31. The fastener according to claim 1, wherein said shaft includes an elongate threaded portion configured to receive a reciprocally threaded nut.
32. The fastener according to claim 1, wherein said shaft includes a longitudinal axial guide bore.

33. The fastener according to claim 32, including an elongate guide element, configured to slidingly pass through said longitudinal axial guide bore.

34. The fastener according to claim 33, wherein said elongate guide element includes a projection configured to press against said shaft during said radial outward movement of said curved wall.

35. The fastener according to claim 34, wherein said radially outwardly projecting element is removably attached to said guide element.

36. The fastener according to claim 34, wherein during said movement, said radially outwardly projecting element is configured to facilitate relative movement between said shaft and said curved wall.

37. The fastener according to claim 34, wherein said radially outwardly projecting element is configured to press against at least a portion of one of:
   - said first end of said curved wall; and
   - said second end of said curved wall.

38. The fastener according to claim 34, wherein said shaft comprises a first end and a second end and said radially outwardly projecting element is configured to press against at least a portion of one of:
   - said first end of said shaft; and
   - said second end of said shaft.

39. The fastener according to claim 1, wherein said shaft comprises at least one shaft retention projection configured to retain said shaft within said axial bore.
40. The fastener according to claim 39, wherein said at least one shaft retention projection is accessible from beyond said shaft.

41. The fastener according to claim 39, wherein said curved wall comprises at least one retention projection receiver, adapted to receive at least a portion of said at least one shaft retention projection during said retention.

42. The fastener according to claim 41, wherein said at least one shaft retention projection includes a cord receptacle configured to receive at least one elongate cord.

43. The fastener according to claim 1, including an elongate curved wall stabilizing cord projecting from said curved wall, said cord configured to stabilize said curved wall with respect to said shaft, while said shaft is being moved into said axial bore.

44. The fastener according to claim 1, including an elongate shaft cord projecting from said shaft, said cord being configured to pull said shaft into said curved wall.

45. The fastener according to claim 1, wherein said shaft comprises a first shaft configured to be pressed against said first end of said curved wall, and said fastener includes a second shaft configured to be pressed against said second end of said curved wall.

46. The fastener according to claim 45, wherein said first shaft and said second shaft include a longitudinal axial guide bore.

47. The fastener according to claim 46, including an elongate guide element, configured to slidingly pass through said longitudinal axial guide bore.
48. The fastener according to claim 47, wherein said elongate guide element includes a projection configured to press against said shaft during said radial outward movement of said curved wall.

49. The fastener according to claim 48, wherein said radially outwardly projecting element is removably attached to said guide element.

50. The fastener according to claim 48, wherein during said movement, said radially outwardly projecting element is configured to facilitate relative movement between said shaft and said curved wall.

51. The fastener according to claim 48, wherein said radially outwardly projecting element is configured to press against at least a portion of one of:

   said first end of said curved wall; and
   said second end of said curved wall.

52. The fastener according to claim 48, wherein said shaft comprises a first end and a second end and said radially outwardly projecting element is configured to press against at least a portion of one of:

   said first end of said shaft; and
   said second end of said shaft.

53. The fastener according to claim 45, wherein said first shaft includes a longitudinal axial guide bore.

54. The fastener according to claim 53, wherein said second shaft includes an elongate guide element, configured to slidingly pass through said longitudinal axial guide bore in said second shaft.

55. The fastener according to claim 54, elongate guide element comprises at least one screw thread and said fastener includes a threaded nut configured to rotate on said at least one screw thread.
56. The fastener according to claim 54, elongate guide element comprises at least one ratchet and said fastener includes a ratchet nut configured to ratchet on said at least one ratchet.

57. The fastener according to claim 54, wherein said curved wall is substantially radially inelastic.

58. The fastener according to claim 54, wherein prior to movement at least a portion of an outer surface of said curved wall is substantially parallel to said longitudinal axis of said axial bore.

59. The fastener according to claim 54, wherein said curved wall is configured to maintain a fixed angle during said radially outward movement.

60. The fastener according to claim 54, wherein following said radial outward movement, at least a portion of an outer surface of said curved wall is substantially parallel to said longitudinal axis of said axial bore.

61. The fastener according to claim 54, wherein said curved wall is configured to maintain a fixed angle during movement.

62. The fastener according to claim 54, wherein said curved wall is substantially radially continuous around said axial bore.

63. The fastener according to claim 62, wherein said curved wall is curvilinear.

64. The fastener according to claim 62, wherein said curved wall is polygonal.
65. The fastener according to claim 54, wherein prior to said radial movement, a first end of said curved wall overlaps a second end of said curved wall.

66. The fastener according to claim 65, wherein following said radial movement, said first end is substantially radially aligned with said second end.

67. The fastener according to claim 1, wherein said curved wall comprises a first curved wall and said fastener includes a second curved wall.

68. The fastener according to claim 67, wherein said first and second curved walls have side edges that interdigitate one with the other.

69. The fastener according to claim 67, wherein said at least two curved walls have side edges that are smooth.

70. A curved wall fastener, comprising:
   an elongate shaft;
   a rearward pointing conus juxtaposed along a rearward portion of said shaft;
   at least one curved wall surrounding at least a portion of said elongate shaft, said curved wall having a rearward edge aligned with a forward surface of said conus; and
   a nut moveably set along a forward portion of said shaft and aligned with a forward edge of said at least one curved wall, said cam nut configured cam against, and cause radially outward movement of said at least one curved wall.

71. The fastener according to claim 70, wherein with respect to a longitudinal axis of the shaft:
at least a portion of the forward edge forms an oblique angle; and
at least a portion of the rearward edge forms an oblique angle.

72. The fastener according to claim 70, wherein said rearward shaft
portion of said shaft includes a flare nut configured to interface with said rearward
edge of said at least one curved wall.

73. The fastener according to claim 70, wherein said at least one curved
wall comprises at least two curved walls; at least one first curved wall member
and at least one second curved wall member.

74. The fastener according to claim 70, including a threaded nut on a
rearward portion of said shaft and said rearward portion of said shaft is reciprocally
threaded to facilitate linear movement of said nut as said shaft is rotated.

75. The fastener according to claim 74, wherein during rotation of said
shaft, said threaded nut is configured to remain substantially rotationally stationary.

76. The fastener according to claim 70, wherein said at least one curved
wall comprises at least two curved walls.

77. The fastener according to claim 76, wherein said at least two curved
walls have side edges that interdigitate one with the other.

78. The fastener according to claim 76, wherein said at least two curved
walls have side edges that are smooth.

79. A curved wall fastener, comprising:
a shaft having two portions, a forward portion and a rearward portion, the rearward shaft portion having a flare;
a linearly moveable nut slidingly disposed on said forward portion of said shaft;
at least one elongate curved wall member juxtaposed along the shaft and adapted to move radially outward with respect to the curved wall as said nut moves toward said flare.

80. The fastener according to claim 79, wherein said linearly moveable nut comprises a ratchet nut and wherein at least a portion of said shaft includes ratchets configured to receive a ratchet projection from said ratchet nut.

81. The fastener according to claim 79, wherein said linearly moveable nut comprises a threaded nut and wherein at least a portion of said shaft is reciprocally threaded to said threaded nut.

82. The fastener according to claim 79, wherein said at least one curved wall comprises at least two curved walls.

83. The fastener according to claim 82, wherein said at least two curved walls have side edges that interdigitate one with the other.

84. The fastener according to claim 82, wherein said at least two curved walls have side edges that are smooth.

85. A sliding nut, comprising:
an elongate threaded shaft;
a nut comprising a body having an axial bore that is partially reciprocally threaded to said threaded shaft; and
a smooth bore at an oblique angle to said axial bore, said smooth bore connected to said axial bore by a passage, said smooth bore and passage being configured to allow linear and pivoting movement of said elongate threaded shaft.

86. The sliding nut of claim 85 including a tube having inner smooth walls axially disposed around said threaded shaft, said tube configured to slidingly received said sliding nut.

87. A method for compressing an in vivo tissue, the method comprising:
   a) boring a bore through a surface of an in vivo tissue;
   b) providing a curved wall having an axial bore and at least one fold along said wall;
   c) positioning said curved wall below said surface of said tissue;
   d) stabilizing said curved wall;
   e) pressing a shaft into said axial bore;
   f) causing at least a portion of said curved wall to move radially outward and press against at least a portion of said bore.

88. The method according to claim 87, wherein the shaft includes an elongate threaded extension and including threading a nut on said elongate threaded extension.

89. The method according to claim 88, including compressing said nut against a tissue surface.

90. The method according to claim 89, including reducing and compressing a fractured bone portion.

91. The method according to claim 88, including placing a graft into said bore and compressing said graft with fastener.