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(54) **ANCHORING SYSTEM AND METHOD FOR SECURING A SUTURE TO A PRE-DRILLED BORE**

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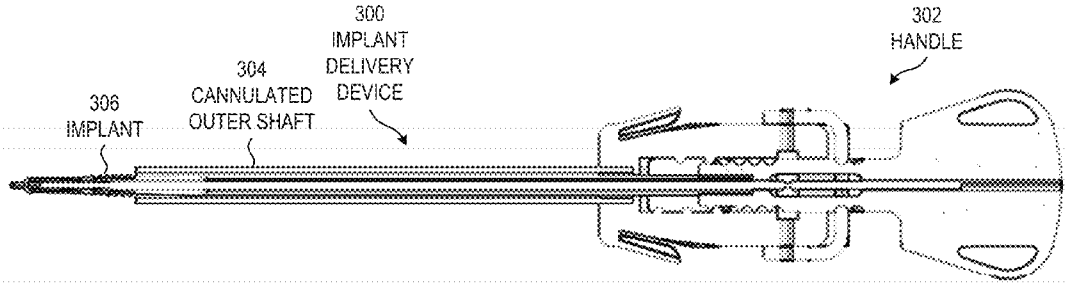
(57) **ABSTRACT**

An anchoring system can use an implant delivery device to deploy an implant into a pre-drilled bore, to secure one or more sutures between a threaded outer surface of an implant body and a wall of the bore. The implant delivery device can controllably rotate the implant about its longitudinal axis. The implant can further include a distal member positioned distal to the implant body and freely rotatable about the longitudinal axis. The implant delivery device can include a finger extending distally from a distal end of an inner shaft. The implant delivery device can controllably translate a wire between a distally extended position, at which the wire can form a closed loop with the finger and a distal end of the inner shaft, and a proximally retracted position, at which the wire can be at least partially retracted into the distal end of the inner shaft.



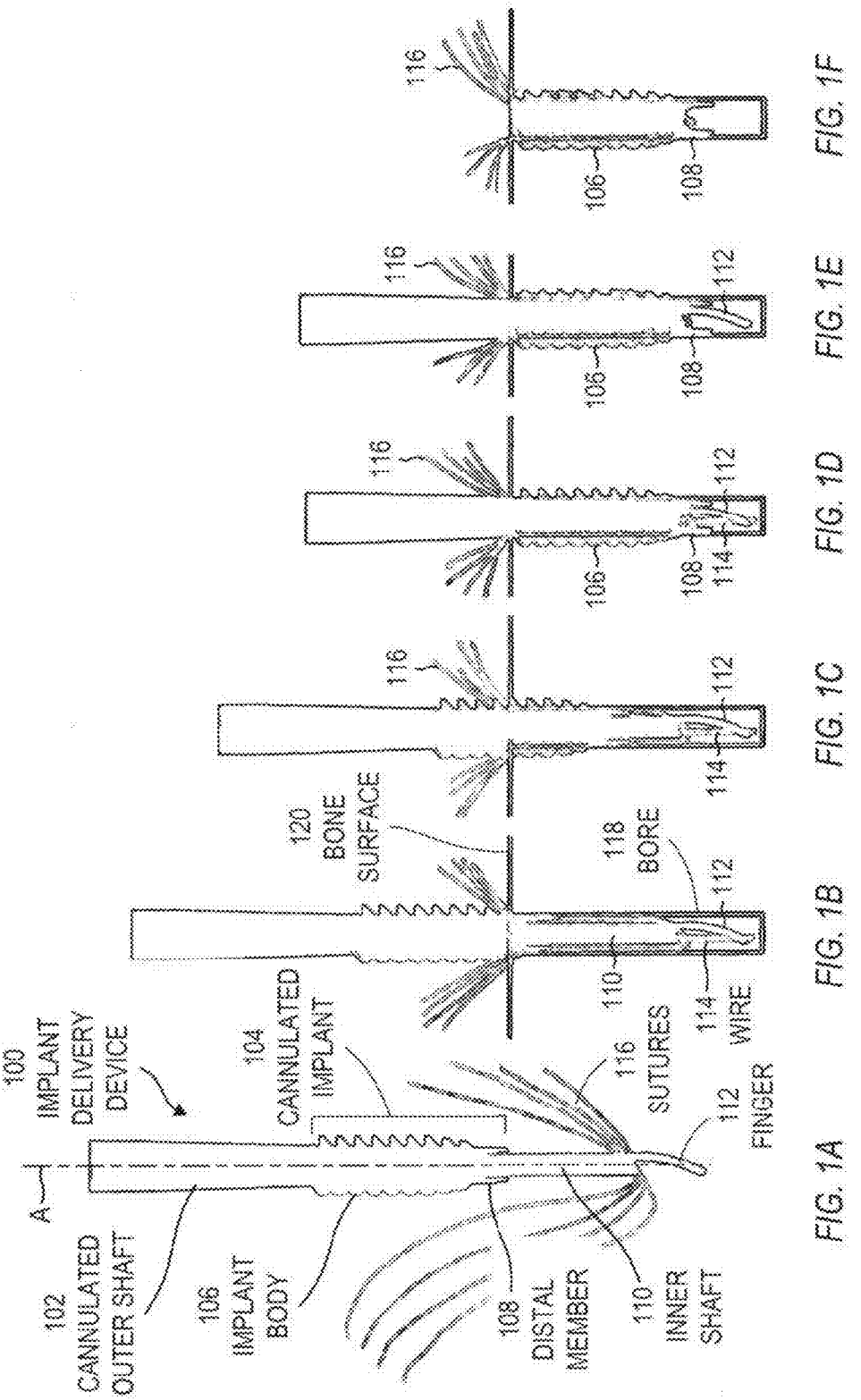


FIG. 1A FIG. 1B FIG. 1C FIG. 1D FIG. 1E FIG. 1F

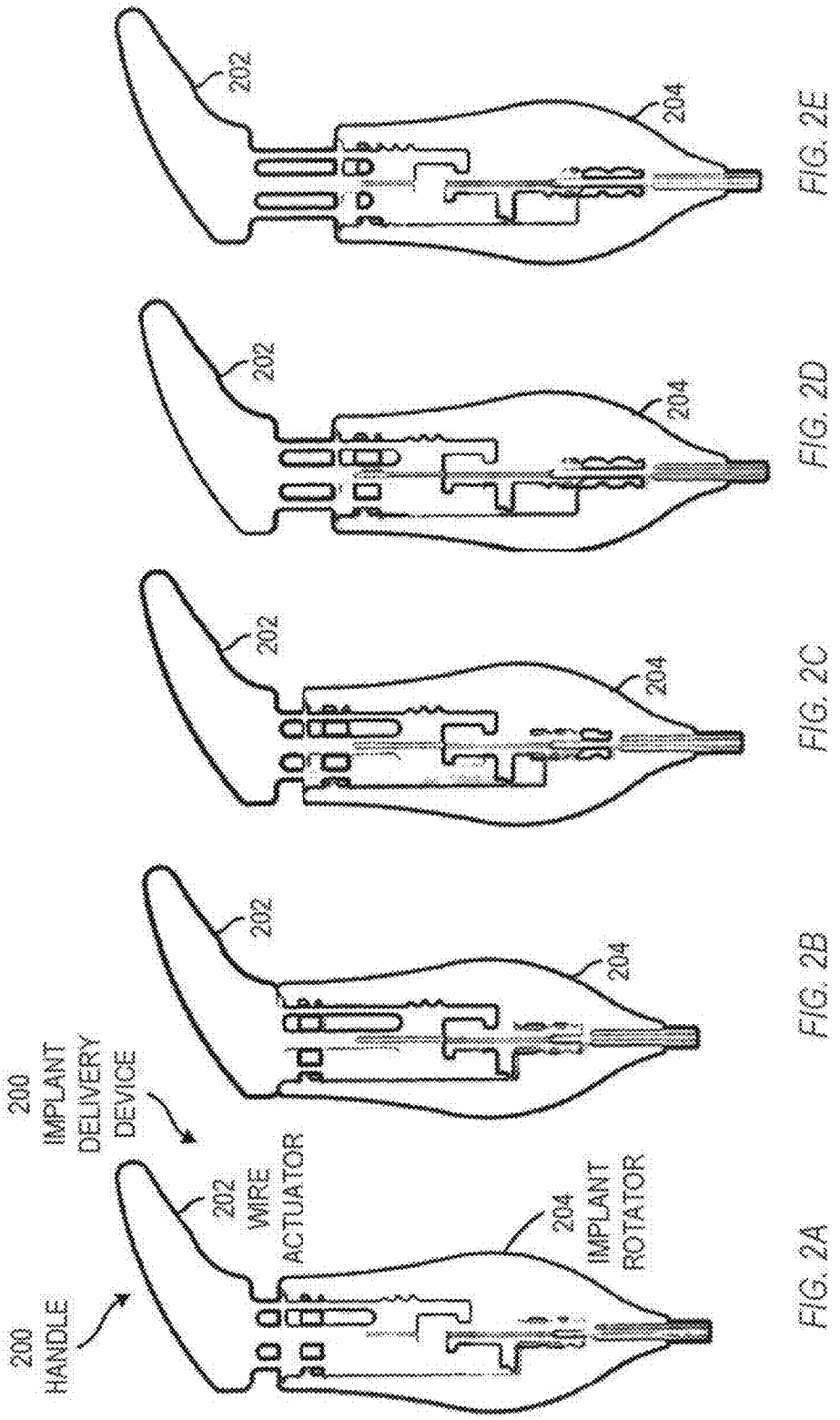


FIG. 2A FIG. 2B FIG. 2C FIG. 2D FIG. 2E

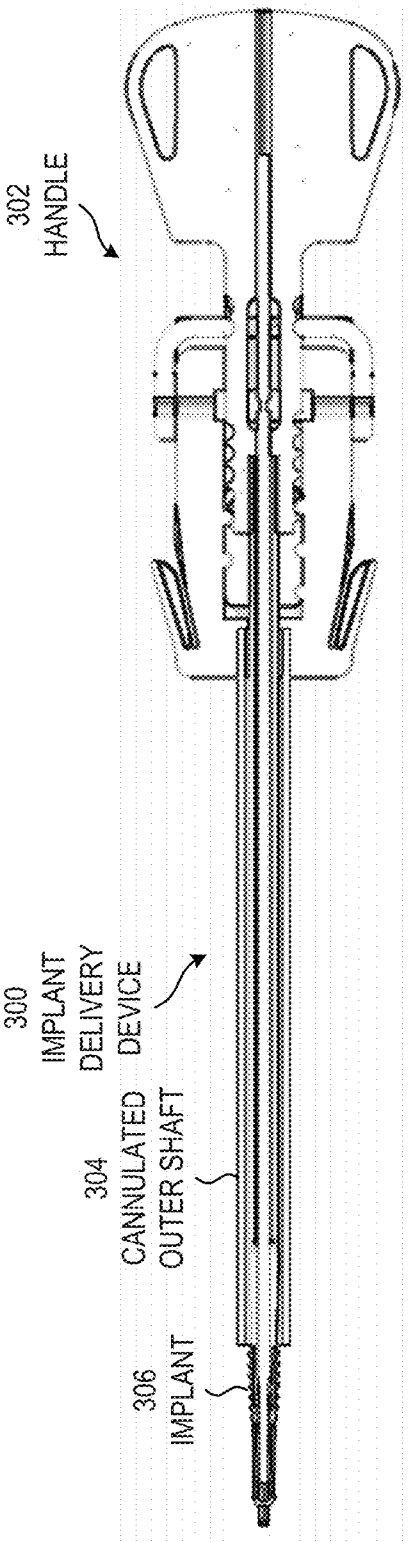
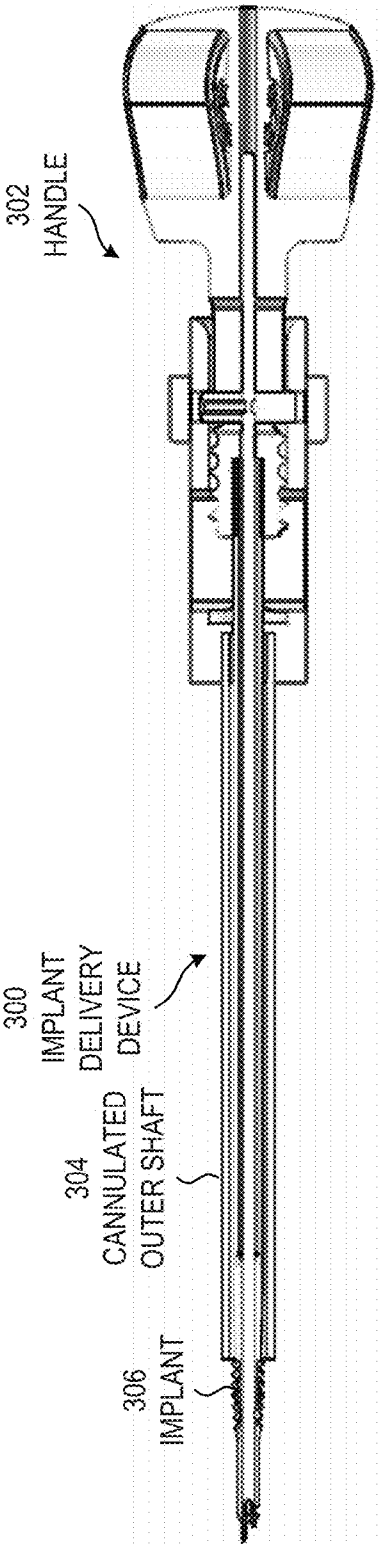

302
HANDLE
300
IMPLANT
DELIVERY
DEVICE
304
CANNULATED
OUTER SHAFT
306
IMPLANT

FIG. 3A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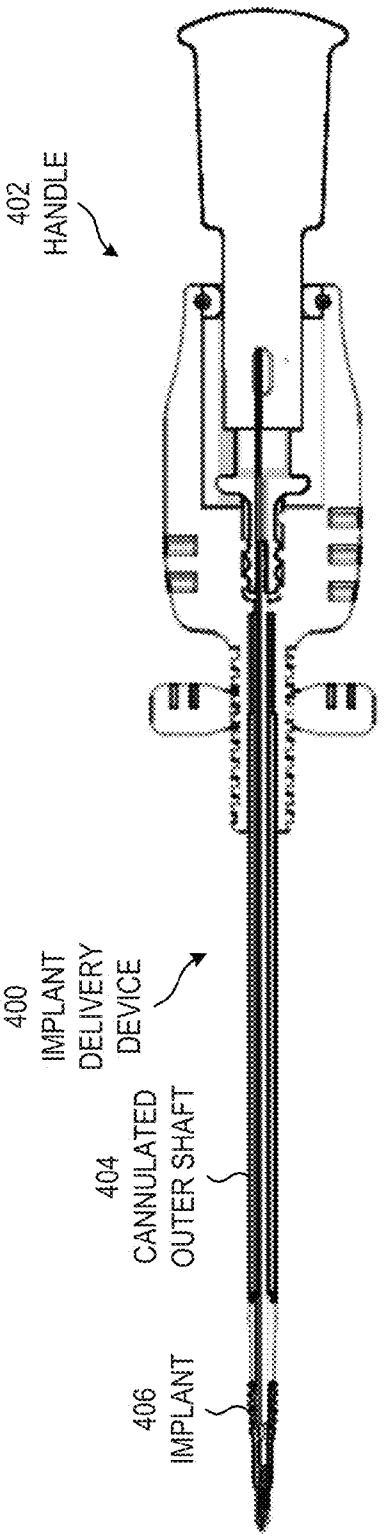
HANDLE
300
IMPLANT
DELIVERY
DEVICE
304
CANNULATED
OUTER SHAFT
306
IMPLANT

FIG. 3B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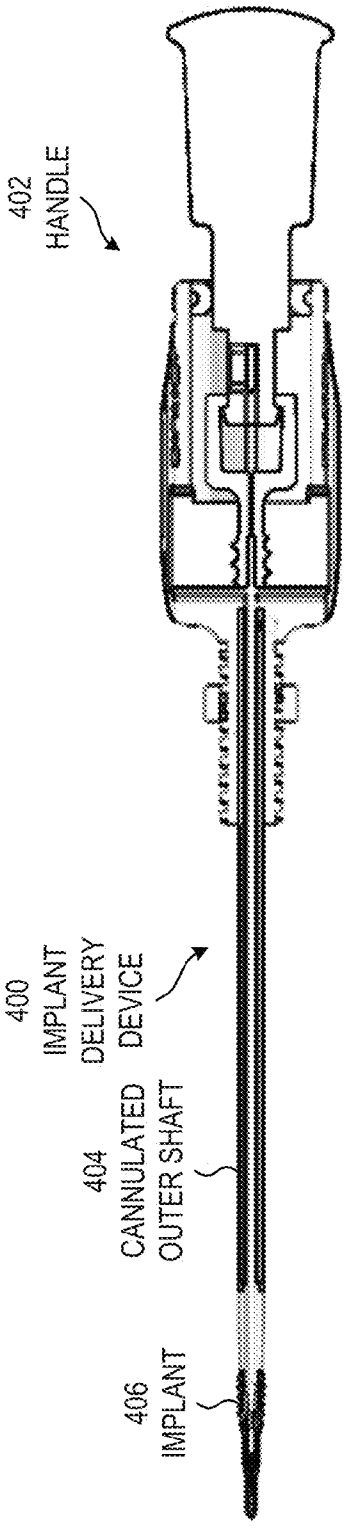
400
IMPLANT
DELIVERY
DEVICE
404
CANNULATED
OUTER SHAFT
406
IMPLANT

FIG. 4A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400
IMPLANT
DELIVERY
DEVICE
404
CANNULATED
OUTER SHAFT
406
IMPLANT

FIG. 4B

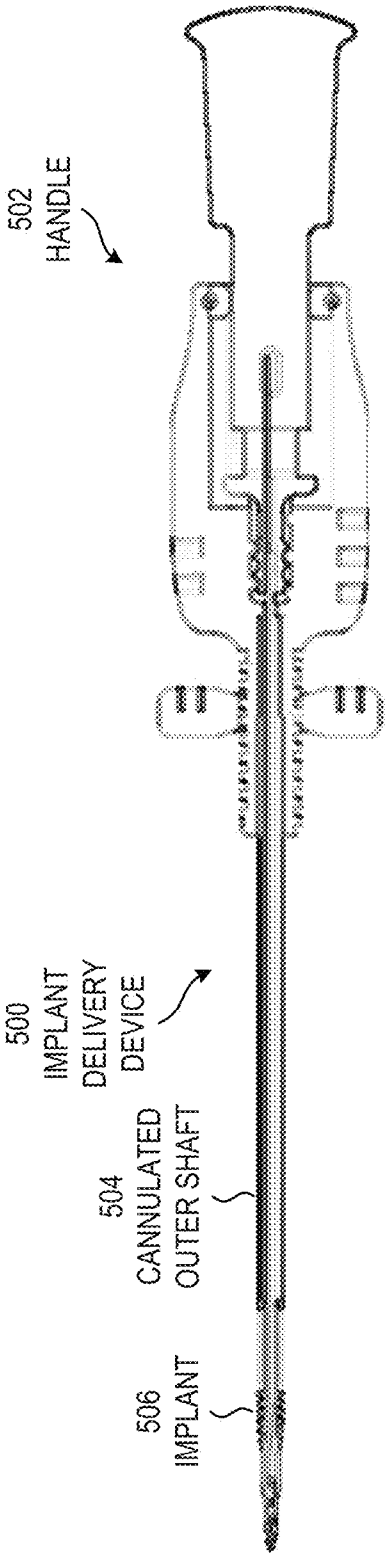
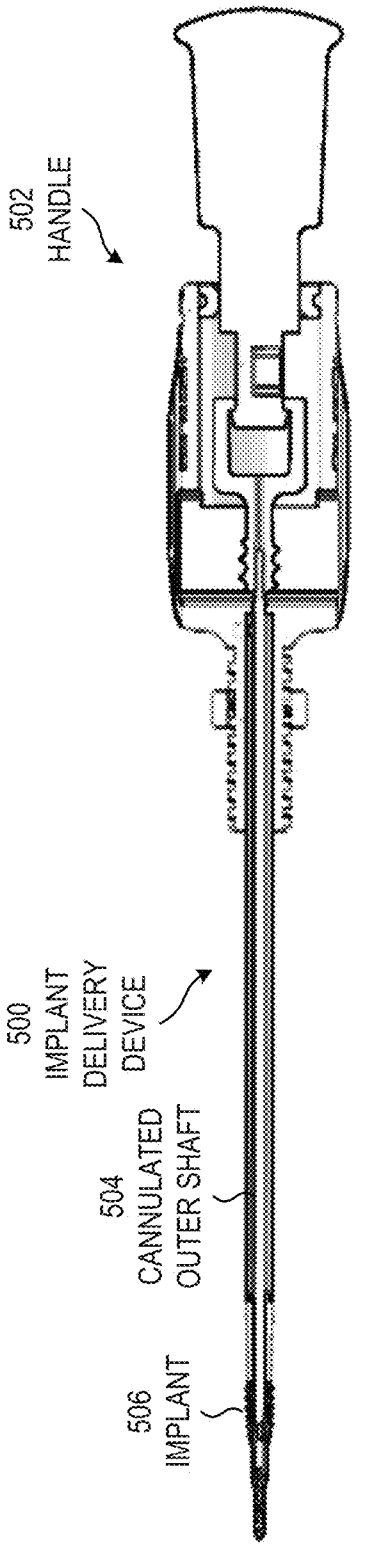

502
HANDLE
500
IMPLANT
DELIVERY
DEVICE
504
CANNULATED
OUTER SHAFT
506
IMPLANT

FIG. 5A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HANDLE
500
IMPLANT
DELIVERY
DEVICE
504
CANNULATED
OUTER SHAFT
506
IMPLANT

FIG. 5B

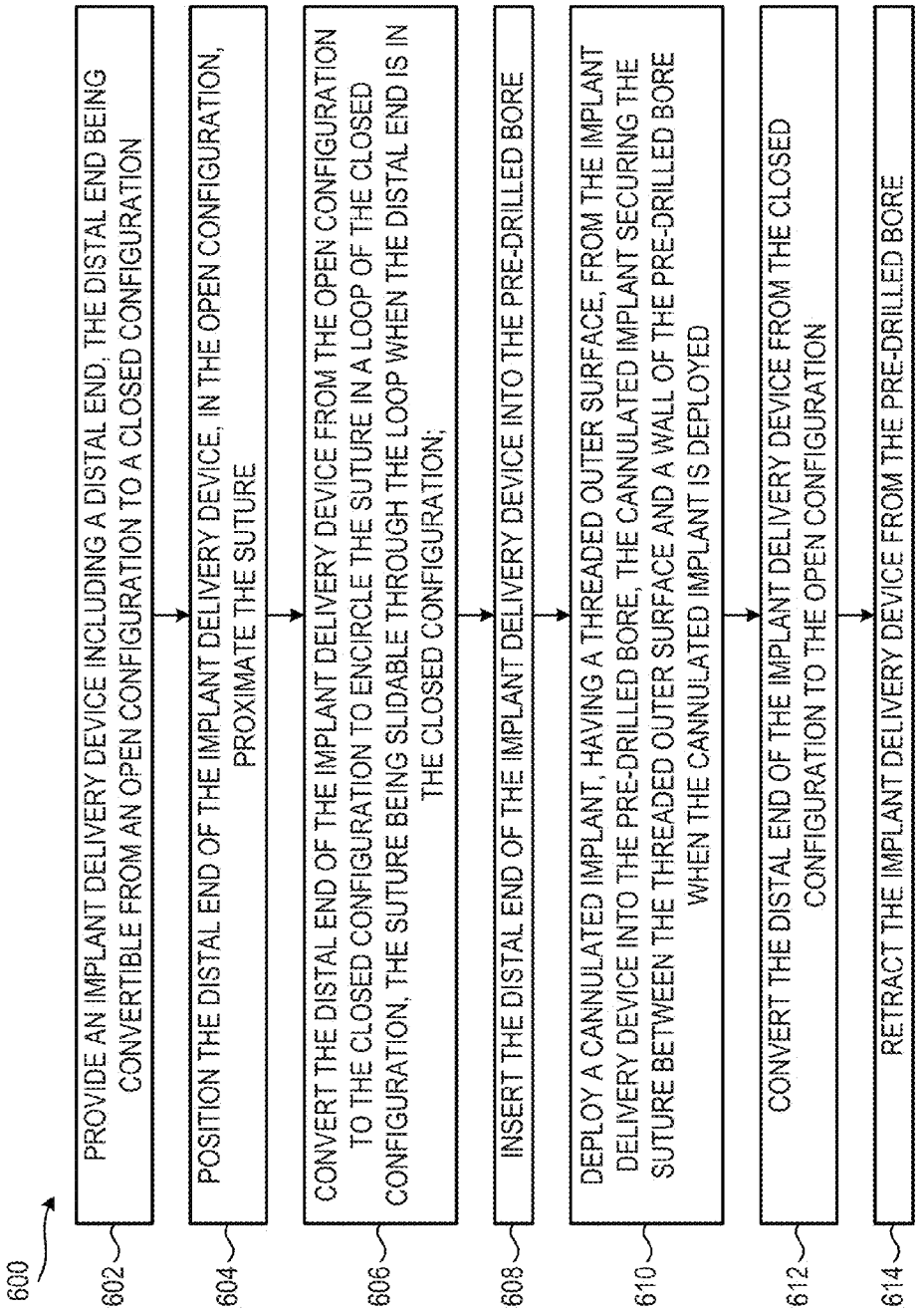
600
602
PROVIDE AN IMPLANT DELIVERY DEVICE INCLUDING A DISTAL END, THE DISTAL END BEING CONVERTIBLE FROM AN OPEN CONFIGURATION TO A CLOSED CONFIGURATION
604
POSITION THE DISTAL END OF THE IMPLANT DELIVERY DEVICE, IN THE OPEN CONFIGURATION, PROXIMATE THE SUTURE
606
CONVERT THE DISTAL END OF THE IMPLANT DELIVERY DEVICE FROM THE OPEN CONFIGURATION TO THE CLOSED CONFIGURATION TO ENCIRCLE THE SUTURE IN A LOOP OF THE CLOSED CONFIGURATION, THE SUTURE BEING SLIDABLE THROUGH THE LOOP WHEN THE DISTAL END IS IN THE CLOSED CONFIGURATION;
608
INSERT THE DISTAL END OF THE IMPLANT DELIVERY DEVICE INTO THE PRE-DRILLED BORE
610
DEPLOY A CANNULATED IMPLANT, HAVING A THREADED OUTER SURFACE, FROM THE IMPLANT DELIVERY DEVICE INTO THE PRE-DRILLED BORE, THE CANNULATED IMPLANT SECURING THE SUTURE BETWEEN THE THREADED OUTER SURFACE AND A WALL OF THE PRE-DRILLED BORE WHEN THE CANNULATED IMPLANT IS DEPLOYED
612
CONVERT THE DISTAL END OF THE IMPLANT DELIVERY DEVICE FROM THE CLOSED CONFIGURATION TO THE OPEN CONFIGURATION
614
RETRACT THE IMPLANT DELIVERY DEVICE FROM THE PRE-DRILLED BORE

FIG. 6

ANCHORING SYSTEM AND METHOD FOR SECURING A SUTURE TO A PRE-DRILLED BORE

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of U.S. Provisional Application No. 62/152,270, filed Apr. 24, 2015, which is hereby incorporated by reference in its entirety.

FIELD OF THE DISCLOSURE

[0002] The present disclosure relates to securing a suture to a pre-drilled bore, such as in a portion of bone.

BACKGROUND OF THE DISCLOSURE

[0003] In the human body, tissue can require repair. For example, a tear in a rotator cuff can require surgical repair of the rotator cuff.

SUMMARY

[0004] In a first embodiment, an anchoring system can include a cannulated implant including an implant body and a distal member that is rotatable relative to the implant body about a longitudinal implant axis. The implant body can include a threaded outer surface. The anchoring system can further include an implant delivery device. The implant delivery device can include a cannulated outer shaft extending along a longitudinal delivery device axis. The cannulated outer shaft can include a distal end configured to rotatably engage a proximal end of the implant body for rotating the implant body with the cannulated outer shaft for driving the cannulated implant into bone. The implant delivery device can further include an inner shaft slidably received in the cannulated outer shaft. A distal end of the inner shaft can be extendable distally beyond the distal end of the cannulated outer shaft such that, when the distal end of the cannulated outer shaft is engaging the proximal end of the implant body, the distal end of the inner shaft is extendable through the cannulated implant to a distance beyond the distal member of the cannulated implant. The implant delivery device can further include a finger extending distally beyond the distal end of the inner shaft. The implant delivery device can further include a wire translatable through the inner shaft from a retracted position to an extended position. The extended position can include a distal end of the wire extending a distance beyond the distal end of the inner shaft such that the wire and the finger form at least part of a closed loop for trapping suture.

[0005] In a second embodiment, a method for securing a suture to a pre-drilled bore, the method can include: providing an implant delivery device including a distal end, the distal end being convertible from an open configuration to a closed configuration; positioning the distal end of the implant delivery device, in the open configuration, proximate the suture; converting the distal end of the implant delivery device from the open configuration to the closed configuration to encircle the suture in a loop of the closed configuration, the suture being slidable through the loop when the distal end is in the closed configuration; inserting the distal end of the implant delivery device into the pre-drilled bore; deploying a cannulated implant, having a threaded outer surface, from the implant delivery device into the pre-drilled bore, the cannulated implant securing the suture between the threaded outer surface and a wall of the pre-drilled bore when the cannulated implant is deployed; converting the distal end of the implant delivery device from the closed configuration to the open configuration; and retracting the implant delivery device from the pre-drilled bore.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] FIGS. **1**A-F show side views of an example of a distal portion of an anchoring system, at sequential stages of operation, in accordance with some embodiments.

[0007] FIGS. **2**A-E show side cross-sectional views of an example of a proximal portion of an implant delivery device for securing sutures to a bore in a bone, at sequential stages of operation, in accordance with some embodiments.

[0008] FIGS. **3**A-B show top and front views of an example of an implant delivery device, including a handle and a cannulated outer shaft, in accordance with some embodiments.

[0009] FIGS. **4**A-B show top and front views of another example of an implant delivery device, including a handle and a cannulated outer shaft, in accordance with some embodiments.

[0010] FIGS. **5**A-B show top and front views of still another example of an implant delivery device, including a handle and a cannulated outer shaft, in accordance with some embodiments.

[0011] FIG. **6** shows a flow chart of an example of a method for securing a suture to a pre-drilled bore, in accordance with some embodiments.

[0012] Corresponding reference characters indicate corresponding parts throughout the several views. Elements in the drawings are not necessarily drawn to scale. The configurations shown in the drawings are merely examples, and should not be construed as limiting the scope of the invention in any manner.

DETAILED DESCRIPTION

[0013] During a surgical process, such as a rotator cuff repair surgery, a surgeon can drill one or more bores in a bone. The surgeon can affix sutures to the bone at each bore. For each hole, the surgeon can deploy an implant with an implant body into the bore, which can secure the suture between the threads of the implant body and the wall of the bore. The device and method discussed herein pertain to the implant, the elements used in an implant delivery device that can deploy the implant, and a method of deploying the implant.

[0014] An anchoring system can use an implant delivery device to deploy an implant into a pre-drilled bore, to secure one or more sutures between a threaded outer surface of an implant body and a wall of the bore. The implant delivery device can controllably rotate the implant about its longitudinal axis. The implant can further include a distal member positioned distal to the implant body and freely rotatable about the longitudinal axis. The implant delivery device can include a finger extending distally from a distal end of an inner shaft. The implant delivery device can controllably translate a wire between a distally extended position, at which the wire can form a closed loop with the finger and a distal end of the inner shaft, and a proximally retracted position, at which the wire can be at least partially retracted into the distal end of the inner shaft.

[0015] FIGS. **1**A-F show side views of an example of a distal portion of an anchoring system, at sequential stages of operation, in accordance with some embodiments. The anchoring system can secure at least one suture to a pre-drilled bore. Although the following discussion references "sutures" in the plural form, it should be understood that the anchoring system can also be used to secure a single suture. The anchoring system of FIGS. **1**A-F is but one example of an anchoring system; other anchoring systems can also be used.

[0016] The anchoring system can include an implant delivery device **100**, which can deploy a cannulated implant **104** in a bore **118** to secure sutures **116** at the location of the bore **118**. In some examples, the cannulated implant **104** can be pre-loaded onto the implant delivery device **100**, and can be shipped with the implant delivery device **100**. In other examples, a practitioner can load the cannulated implant **104** onto the implant delivery device **100**, as needed. In these examples, the cannulated implant **104** and the sutures **116** are not part of the implant delivery device **100**.

[0017] The implant delivery device **100** can include a cannulated outer shaft **102** extending along a longitudinal axis (A) of the implant delivery device **100**.

[0018] The cannulated outer shaft **102** can include at least two concentric elements extending longitudinally from a proximal portion of the cannulated outer shaft **102** to a distal portion of the cannulated outer shaft **102**. For example, the cannulated outer shaft **102** can include two or more concentric tubes, or one or more concentric tubes disposed over a wire. One of the concentric elements can be rotated about the longitudinal axis, with respect to another of the concentric elements. When a surgeon initiates a rotation initiated at a handle at a proximal portion of the implant delivery device **100**, the concentric elements can couple the rotation to a distal portion of the implant delivery device **100**, and can rotate an implant body **106** of a cannulated implant **104** (discussed in detail below).

[0019] The cannulated outer shaft **102** can also include two elements that can couple a longitudinal translation with respect to each other from the proximal portion of the cannulated outer shaft **102** to the distal portion of the cannulated outer shaft **102**. When a surgeon initiates a translation at the handle at the proximal portion of the implant delivery device **100**, the elements can couple the translation to the distal portion of the implant delivery device **100**, and can translate a wire **114** (also discussed in detail below).

[0020] During a surgical procedure, the implant delivery device **100** can deploy a cannulated implant **104**. The cannulated implant **104** remains anchored in the bone after the procedure has been completed, while the implant delivery device **100** is removed. The cannulated implant **104** locks the sutures **116** to the bore by trapping the sutures **116** between external threads on the cannulated implant **104** and a wall of the bore **118**. Prior to deployment, the cannulated implant **104** can be disposed over the distal portion of the cannulated outer shaft **102**.

[0021] The cannulated implant **104** can be disposed over a distal portion of the cannulated outer shaft **102**, which can be positioned at a distal portion of the implant delivery device **100**.

[0022] The cannulated implant **104** can include an implant body **106** having at least one exterior thread and configured to controllably rotate about a longitudinal axis of the implant body **106** (coinciding with A in FIG. **1**A). The implant body **106** can include external threads that have an external diameter larger than a diameter of the bore **118**. As the surgeon initiates the rotation from the handle, the implant body **106** can rotate around the longitudinal axis, and the threads can screw into the wall of the bore. In some examples, the implant body **106** can slide freely over the distal portion of the cannulated outer shaft **102**. In other examples, the implant body **106** can additionally include internal threads having the same pitch as the external threads, so that as the implant body **106** rotates, the implant body moves distally along the cannulated outer shaft **102** at the same rate at which the external threads cut into the wall of the bore **118**. Friction between the bone and the implant body **106** can secure the cannulated implant **104** in place in the bore **118** after the surgical procedure has been completed. This friction can, in turn, secure the sutures **116** in place, as well.

[0023] The cannulated implant **104** can further including a distal member **108** positioned distal to the implant body **106** and freely rotatable about the longitudinal axis. A distal end of the distal member **108** can include a pair of distal-extending prongs positioned on opposite sides of the longitudinal axis of the implant delivery device **100**. As the surgeon rotates the implant body **106**, the distal member **108** initially rotates along with the implant body **106**. As the implant body **106** moves distally, the distal member **108** eventually contacts the sutures **116**. The prongs on the distal member **108** naturally position themselves on opposite sides of the sutures **116** (due to the free rotation), and remain on opposite sides of the sutures **116** as the implant body is **106** is advanced distally to its final position. Once the implant body **106** is advanced fully, the distal member **108** can help prevent the sutures **116** from being pulled proximally as the implant delivery device **100** is removed through a center of the cannulated implant **104**.

[0024] An inner shaft **110** can extend distally from a distal end of the cannulated outer shaft **110** and can extend at least partially through an interior of the cannulated implant **104**.

[0025] A finger **112** can extend distally from a distal end of the inner shaft **110**. The finger **112** can have a smaller cross-section than the inner shaft **110**, when viewed end-on from a distal end of the device **100**. The finger **112** can be laterally offset from the longitudinal axis of the implant delivery device **100**. In some examples, the finger **112** can curve from a first lateral edge of the inner shaft **110** toward a second lateral edge of the inner shaft **110**, opposite the first lateral edge. In some examples, the proximal and distal ends of the finger **112** can be on opposite sides of the longitudinal axis of the implant delivery device **100**.

[0026] A wire **114** can be controllably translatable between a distally extended position, at which the wire **114** forms a closed loop with the finger **112** and a distal end of the inner shaft **110**, and a proximally retracted position, at which the wire **114** is at least partially retracted into the distal end of the inner shaft **110**. In some examples, the wire **114** can extend parallel to the finger **112** at a proximal portion of the finger **112**. The wire **114** can be shaped so that when the wire is fully extended proximally, the wire **114** can contact a proximal portion of the finger **112**, and can form a closed loop from the wire **114**, finger **112**, and distal end of the inner shaft **110**. In some examples, the wire **114** can be formed as a rod, a tube, or other element that can translate longitudinally. In some examples, the wire **114** can option-

ally include one or more slots, holes, or notches, which can increase the flexibility of the wire **114**. The wire **114** can be formed from a metal, plastic, or another suitable material.

[0027] A surgeon can open or close the loop from the handle. To do so, the surgeon can impart a longitudinal translation to an element at the handle. The cannulated outer shaft **102** coupled the longitudinal translation from the handle at the proximal portion of the implant delivery device **100** to the distal portion of the implant delivery device **100**, and to the wire **114**. The surgeon can retract the wire **114** proximally (thereby opening the loop), or advance the wire **114** distally (thereby closing the loop). The loop can extend over an area, referred to as a window. During a stage of surgery, a surgeon can open the loop (e.g., open the window), position the device **100** so that sutures **116** extend across the finger **112** or distal end of the inner shaft **110** (e.g., the sutures pass through the window), and close the loop. When the loop is closed, the sutures **116** pass through the loop. The surgeon can use this loop to pull the sutures **116** distally to a bottom of the bore **118**, then can open the loop and withdraw the inner shaft **110** and finger **112** proximally. The distal member **108** can hold the distalmost portions of the sutures **116** in place when the inner shaft **110** and finger **112** are withdrawn.

[0028] Prior to use, the implant delivery device **100** can have its loop either open or closed (e.g., can have the wire **114** retracted proximally or advanced distally). As a first stage during use, the surgeon can position the implant delivery device **100**, with the loop open, to "grab" the relevant sutures **116** in the loop. This positioning is performed outside the bone.

[0029] In FIG. **1**A, the surgeon has grabbed the sutures **116** in the window. At this stage of the surgery, the surgeon has positioned the implant delivery device **100** so that the sutures **116** extend along a distal end of the inner shaft **110** or the finger **112**, and the wire **114** is retracted proximally. Next the surgeon manipulates the handle (not shown) of the implant delivery device **100** to distally advance the wire **114** to contact the finger **112**, thereby closing the loop. The sutures **116** pass through the closed loop, so that the surgeon can position the sutures **116** by positioning the device **100**.

[0030] Next, the surgeon can insert a distal end of the implant delivery device **100**, with the sutures **116**, into the bore **118** in the bone. In FIG. **1**B, the surgeon has advanced the implant delivery device **100** distally until the sutures **116** are at or near a bottom of the bore **118**, and/or until the implant body **106** contacts a proximal end of the bore **118**. With the implant delivery device **100** positioned as in FIG. **1**B, the surgeon can adjust the sutures **116** at locations away from the device **100**, if needed. For example, if needed, the surgeon can tighten the sutures **116** at respective tissue sites, such as for a rotator cuff under repair.

[0031] Next, the surgeon can manipulate the handle (not shown) to rotate the implant body **106** about the longitudinal axis. Such manipulation can distally advance the cannulated implant **104** into the bore **118**, as the threads in the implant body **106** engage the wall of the bore **118**. The sutures **116** extend distally along one side of the implant body **106** between the threads and the wall of the bore **118**, pass through the loop (formed by the wire **114**, the finger **112**, and the distal end of the bore **118**), and extend proximally along an opposite side of the implant body **106** between the threads and the wall of the bore **118**. During this advancement of the cannulated implant **104**, the inner shaft **110**, finger **112**, sutures **116**, and wire **114** may remain at the same longitudinal position along the bore. In FIG. **1**C, the surgeon is halfway through the advancing.

[0032] The surgeon can distally advance the cannulated implant **104** into the bore **118** at least until a proximal end of the cannulated implant **104** is flush with a surface **120** of the bone. In FIG. **1**D, the surgeon has fully advanced the cannulated implant **104** into the bore **118**. At this position, the distal member **108** can be positioned next to the sutures **116**, so that the distally-extending prongs on the distal member **108** extend on opposite sides of the sutures **116**.

[0033] Next, the surgeon can manipulate the handle (not shown) to proximally withdraw the wire **114** into the inner shaft **110**, thereby opening the loop. In FIG. **1**E, the loop has been opened.

[0034] Next, the surgeon can proximally withdraw the implant delivery device **100** (including the cannulated outer shaft **102**, the inner shaft **110**, the finger **112**, and the wire **114**) from the bore **118**, leaving the cannulated implant **104** (including the implant body **106** and the distal member **108**) and the sutures **116** in the bore **118**. In FIG. **1**F, just the implant body **106**, the distal member **108**, and the sutures **116** remain in the bore **118**. The sutures **116** extend distally along one side of the implant body **106** between the threads and the wall of the bore **118**, pass between the distally-extending prongs of the distal member **108**, and extend proximally along an opposite side of the implant body **106** between the threads and the wall of the bore **118**. The threads form an interference fit that holds the sutures **116** in place. In the stage of FIG. **1**F, the cannulated implant **104** is fully implanted.

[0035] The elements shown in FIGS. **1**A-F can be positioned at a distal end of the implant delivery device **100**. At a proximal end of the implant delivery device **100**, a handle can control the rotation of the implant body **106** and a proximal/distal position of the wire **114**. There are many possible configurations for such a handle. FIGS. **2**A-E show one such configuration.

[0036] FIGS. **2**A-E show side cross-sectional views of an example of a proximal portion of an implant delivery device **100** for securing sutures to a bore **118** in a bone, at sequential stages of operation, in accordance with some embodiments. The configuration of FIGS. **2**A-E is but one example; other suitable configurations can also be used.

[0037] In the example of FIGS. **2**A-E, the implant delivery device **100** can include a handle **200** at a proximal end of the implant delivery device **100**. The handle **200** can include a wire actuator **202** at a proximal end of the handle **200**, and an implant rotator **204** distal to the wire actuator **202**. By translating the wire actuator **202** proximally or distally with respect to the implant rotator **204**, a surgeon can proximally retract or distally advance the wire **114** with respect to the inner shaft **110** (FIG. **1**B). By rotating the implant rotator **204** with respect to the wire actuator **202**, the surgeon can rotate the implant body **106** around the longitudinal axis.

[0038] In FIG. **2**A, the wire actuator **202** has been pulled proximally from the implant rotator **204**, so that the wire **114** is proximally retracted in the inner shaft **110**. The loop is open. The state of the handle **200** in FIG. **2**A corresponds to the state of the device **100** in FIG. **1**A.

[0039] In FIG. **2**B, the wire actuator **202** has been pushed distally toward the implant rotator **204**, so that the wire **114** is distally advanced toward the finger **112**. The loop is

closed. The state of the handle **200** in FIG. **2**B corresponds to the state of the device **100** in FIG. **1**B.

[0040] In FIG. **2**C, the implant rotator **204** has been rotated with respect to the wire actuator **202**, to roughly half its range of travel. The loop is closed. The state of the handle **200** in FIG. **2**C corresponds to the state of the device **100** in FIG. **1**C.

[0041] In FIG. **2**D, the implant rotator **204** has been rotated with respect to the wire actuator **202**, to the end of its range of travel. The loop is closed. The state of the handle **200** in FIG. **2**D corresponds to the state of the device **100** in FIG. **1**D.

[0042] In FIG. **2**E, the wire actuator **202** has been pulled proximally from the implant rotator **204**, so that the wire **114** is proximally retracted in the inner shaft **110**. The loop is open. The state of the handle **200** in FIG. **2**E corresponds to the state of the device **100** in FIG. **1**E.

[0043] It will be understood that that handle configuration and the actuator configurations of FIGS. **2**A-**2**E are but examples, and that other suitable configurations can be used for the handle and actuators. FIGS. **3**-**5** show examples of such other suitable configurations.

[0044] FIGS. **3**A-B show top and front views of an example of an implant delivery device **300**, including a handle **302** and a cannulated outer shaft **304**, in accordance with some embodiments. An implant **306** is configured to be deployed by the implant delivery device **300**.

[0045] FIGS. **4**A-B show top and front views of another example of an implant delivery device **400**, including a handle **402** and a cannulated outer shaft **404**, in accordance with some embodiments. An implant **406** is configured to be deployed by the implant delivery device **400**.

[0046] FIGS. **5**A-B show top and front views of still another example of an implant delivery device **500**, including a handle **502** and a cannulated outer shaft **504**, in accordance with some embodiments. An implant **506** is configured to be deployed by the implant delivery device **500**.

[0047] The configurations of FIGS. **3**-**5** are but examples of implant delivery devices. In each configuration, and others not shown, the handles can include suitable mechanisms to deploy the implant, including a mechanism configured to transmit torque or rotation to the implant, and a mechanism configured to transmit longitudinal translation to the wire.

[0048] FIG. **6** shows a flow chart of an example of a method **600** for securing a suture to a pre-drilled bore, in accordance with some embodiments. The method **600** can be executed by a surgeon using an anchoring system, such as the anchoring system shown in FIGS. **1**-**5**, or others. The method **600** is but one example for securing a suture to a pre-drilled bore; other suitable methods can also be used.

[0049] At operation **602**, the surgeon can provide an implant delivery device including a distal end, the distal end being convertible from an open configuration to a closed configuration.

[0050] At operation **604**, the surgeon can position the distal end of the implant delivery device, in the open configuration, proximate the suture.

[0051] At operation **606**, the surgeon can convert the distal end of the implant delivery device from the open configuration to the closed configuration to encircle the suture in a loop of the closed configuration, the suture being slidable through the loop when the distal end is in the closed configuration.

[0052] At operation **608**, the surgeon can insert the distal end of the implant delivery device into the pre-drilled bore.

[0053] At operation **610**, the surgeon can deploy a cannulated implant, having a threaded outer surface, from the implant delivery device into the pre-drilled bore, the cannulated implant securing the suture between the threaded outer surface and a wall of the pre-drilled bore when the cannulated implant is deployed.

[0054] At operation **612**, the surgeon can convert the distal end of the implant delivery device from the closed configuration to the open configuration.

[0055] At operation **614**, the surgeon can retract the implant delivery device from the pre-drilled bore.

[0056] In some examples, the implant delivery device can further include two concentric elements extending along a longitudinal axis of the implant delivery device from a proximal portion of the implant delivery device to a distal portion of the implant delivery device. In these examples, controllably rotating the implant body about the longitudinal axis of the implant delivery device can include at the proximal portion of the implant delivery device, imparting a rotation to one of the concentric elements with respect to the other of the concentric elements; and coupling the rotation from proximal portions of the concentric elements to distal portions of the concentric elements; and coupling the rotation from the distal portions of the concentric elements to the implant body. In some examples, the two concentric elements are the cannulated outer shaft and the inner shaft.

[0057] To further illustrate the device and related method disclosed herein, a non-limiting list of examples is provided below. Each of the following non-limiting examples can stand on its own, or can be combined in any permutation or combination with any one or more of the other examples.

[0058] In Example 1, an anchoring system comprises a cannulated implant including an implant body and a distal member that is rotatable relative to the implant body about a longitudinal implant axis, the implant body including a threaded outer surface; and an implant delivery device, comprising: a cannulated outer shaft extending along a longitudinal delivery device axis, the cannulated outer shaft including a distal end configured to rotatably engage a proximal end of the implant body for rotating the implant body with the cannulated outer shaft for driving the cannulated implant into bone; an inner shaft slidably received in the cannulated outer shaft, wherein a distal end of the inner shaft is extendable distally beyond the distal end of the cannulated outer shaft such that, when the distal end of the cannulated outer shaft is engaging the proximal end of the implant body, the distal end of the inner shaft is extendable through the cannulated implant to a distance beyond the distal member of the cannulated implant; a finger extending distally beyond the distal end of the inner shaft; and a wire translatable through the inner shaft from a retracted position to an extended position, the extended position including a distal end of the wire extending a distance beyond the distal end of the inner shaft such that the wire and the finger form at least part of a closed loop for trapping suture.

[0059] In Example 2, the device of Example 1 can optionally be configured such that the finger has a smaller cross-section than the inner shaft, when viewed end-on from a distal end of the implant delivery device.

[0060] In Example 3, the device of any one or a combination of Examples 1-2 can optionally be configured such that the finger is laterally offset from the longitudinal delivery device axis.

[0061] In Example 4, the device of any one or a combination of Examples 1-3 can optionally be configured such that the finger curves from a first lateral edge of the inner shaft toward a second lateral edge of the inner shaft, opposite the first lateral edge.

[0062] In Example 5, the device of any one or a combination of Examples 1-4 can optionally be configured such that a proximal end of the finger and a distal end of the finger are disposed on opposite sides of the longitudinal delivery device axis.

[0063] In Example 6, the device of any one or a combination of Examples 1-5 can optionally be configured such that the wire extends parallel to the finger at a proximal portion of the finger.

[0064] In Example 7, the device of any one or a combination of Examples 1-6 can optionally be configured such that the wire is shaped so that when the wire is in the extended position, the wire contacts a distal portion of the finger.

[0065] In Example 8, the device of any one or a combination of Examples 1-7 can optionally be configured such that the distal member includes include a pair of distally-extending prongs positioned on opposite sides of the longitudinal implant axis.

[0066] In Example 9, the device of any one or a combination of Examples 1-8 can optionally be configured such that the distal member is configured so that as the cannulated implant is advanced distally to a first position at which the prongs and trapped suture are at the same longitudinal location, the distal member is able to freely rotate to position the prongs on opposite sides of the trapped suture.

[0067] In Example 10, the device of any one or a combination of Examples 1-9 can optionally be configured such that as the cannulated implant is advanced distally beyond the first position, the prongs are able to remain on opposite sides of the trapped suture.

[0068] In Example 11, the device of any one or a combination of Examples 1-10 can optionally be configured such that a proximal portion of the implant delivery device is coupled to a handle; the handle includes a wire actuator configured to controllably translate the wire; and the handle includes an implant actuator configured to controllably rotate the cannulated implant about the longitudinal implant axis.

[0069] In Example 12, the device of any one or a combination of Examples 1-11 can optionally be configured such that the implant actuator is configured to controllably rotate the cannulated outer shaft about the longitudinal delivery device axis and thereby controllably rotate the cannulated implant about the longitudinal implant axis.

[0070] In Example 13, the device of any one or a combination of Examples 1-12 can optionally be configured such that the threaded outer surface is configured to cut into a wall of a pre-drilled bore as the cannulated implant is rotated about the longitudinal implant axis; and the implant body further includes a threaded inner surface, the threaded inner surface having a pitch matched to a pitch of the threaded outer surface, so that as the cannulated implant is rotated about the longitudinal implant axis, the cannulated implant is able to move distally along the inner shaft at the same rate at which the threaded outer surface cuts into the wall of the pre-drilled bore.

[0071] In Example 14, the device of any one or a combination of Examples 1-13 can optionally be configured such that when the wire is in the extended position, the wire and the finger form a fully closed loop for trapping the suture.

[0072] In Example 15, the device of any one or a combination of Examples 1-14 can optionally be configured such that when the wire is in the extended position, the wire, the finger, and the distal end of the inner shaft form a fully closed loop for trapping the suture.

[0073] In Example 16, a method for securing a suture to a pre-drilled bore comprises: providing an implant delivery device including a distal end, the distal end being convertible from an open configuration to a closed configuration; positioning the distal end of the implant delivery device, in the open configuration, proximate the suture; converting the distal end of the implant delivery device from the open configuration to the closed configuration to encircle the suture in a loop of the closed configuration, the suture being slidable through the loop when the distal end is in the closed configuration; inserting the distal end of the implant delivery device into the pre-drilled bore; deploying a cannulated implant, having a threaded outer surface, from the implant delivery device into the pre-drilled bore, the cannulated implant securing the suture between the threaded outer surface and a wall of the pre-drilled bore when the cannulated implant is deployed; converting the distal end of the implant delivery device from the closed configuration to the open configuration; and retracting the implant delivery device from the pre-drilled bore.

[0074] In Example 17, the method of Example 16 can optionally be configured such that deploying the cannulated implant comprises: controllably rotating the cannulated implant about a longitudinal implant axis of the cannulated implant.

[0075] In Example 18, the method of any one or a combination of Examples 16-17 can optionally be configured such that controllably rotating the cannulated implant about a longitudinal implant axis of the cannulated implant comprises: at a proximal portion of the implant delivery device, imparting a rotation to a cannulated outer shaft of the implant delivery device; and rotatably coupling a distal end of the cannulated outer shaft to a proximal end of the cannulated implant.

[0076] In Example 19, the method of any one or a combination of Examples 16-18 can optionally be configured such that converting the distal end of the implant delivery device from the open configuration to the closed configuration comprises: controllably advancing a portion of a wire from within an inner shaft of the implant delivery device to contact a distally-extending finger at the distal end of the implant delivery device.

[0077] In Example 20, the method of any one or a combination of Examples 16-19 can optionally be configured such that converting the distal end of the implant delivery device from the closed configuration to the open configuration comprises: controllably retracting the portion of the wire into the inner shaft.

[0078] While this invention has been described as having example designs, the present invention can be further modified within the spirit and scope of this disclosure. This application is therefore intended to cover any variations,

uses, or adaptations of the invention using its general principles. Further, this application is intended to cover such departures from the present disclosure as come within known or customary practice in the art to which this invention pertains and which fall within the limits of the appended claims.

What is claimed is:

1. An anchoring system, comprising:

a cannulated implant including an implant body and a distal member that is rotatable relative to the implant body about a longitudinal implant axis, the implant body including a threaded outer surface; and

an implant delivery device, comprising:

a cannulated outer shaft extending along a longitudinal delivery device axis, the cannulated outer shaft including a distal end configured to rotatably engage a proximal end of the implant body for rotating the implant body with the cannulated outer shaft for driving the cannulated implant into bone;

an inner shaft slidably received in the cannulated outer shaft, wherein a distal end of the inner shaft is extendable distally beyond the distal end of the cannulated outer shaft such that, when the distal end of the cannulated outer shaft is engaging the proximal end of the implant body, the distal end of the inner shaft is extendable through the cannulated implant to a distance beyond the distal member of the cannulated implant;

a finger extending distally beyond the distal end of the inner shaft; and

a wire translatable through the inner shaft from a retracted position to an extended position, the extended position including a distal end of the wire extending a distance beyond the distal end of the inner shaft such that the wire and the finger form at least part of a closed loop for trapping suture.

2. The anchoring system of claim **1**, wherein the finger has a smaller cross-section than the inner shaft, when viewed end-on from a distal end of the implant delivery device.

3. The anchoring system of claim **1**, wherein the finger is laterally offset from the longitudinal delivery device axis.

4. The anchoring system of claim **1**, wherein the finger curves from a first lateral edge of the inner shaft toward a second lateral edge of the inner shaft, opposite the first lateral edge.

5. The anchoring system of claim **4**, wherein a proximal end of the finger and a distal end of the finger are disposed on opposite sides of the longitudinal delivery device axis.

6. The anchoring system of claim **1**, wherein the wire extends parallel to the finger at a proximal portion of the finger.

7. The anchoring system of claim **1**, wherein the wire is shaped so that when the wire is in the extended position, the wire contacts a distal portion of the finger.

8. The anchoring system of claim **1**, wherein the distal member includes include a pair of distally-extending prongs positioned on opposite sides of the longitudinal implant axis.

9. The anchoring system of claim **8**, wherein the distal member is configured so that as the cannulated implant is advanced distally to a first position at which the prongs and trapped suture are at the same longitudinal location, the distal member is able to freely rotate to position the prongs on opposite sides of the trapped suture.

10. The anchoring system of claim **9**, wherein as the cannulated implant is advanced distally beyond the first position, the prongs are able to remain on opposite sides of the trapped suture.

11. The anchoring system of claim **1**, wherein:

a proximal portion of the implant delivery device is coupled to a handle;

the handle includes a wire actuator configured to controllably translate the wire; and

the handle includes an implant actuator configured to controllably rotate the cannulated implant about the longitudinal implant axis.

12. The anchoring system of claim **11**, wherein the implant actuator is configured to controllably rotate the cannulated outer shaft about the longitudinal delivery device axis and thereby controllably rotate the cannulated implant about the longitudinal implant axis.

13. The anchoring system of claim **12**, wherein:

the threaded outer surface is configured to cut into a wall of a pre-drilled bore as the cannulated implant is rotated about the longitudinal implant axis; and

the implant body further includes a threaded inner surface, the threaded inner surface having a pitch matched to a pitch of the threaded outer surface, so that as the cannulated implant is rotated about the longitudinal implant axis, the cannulated implant is able to move distally along the inner shaft at the same rate at which the threaded outer surface cuts into the wall of the pre-drilled bore.

14. The anchoring system of claim **1**, wherein when the wire is in the extended position, the wire and the finger form a fully closed loop for trapping the suture.

15. The anchoring system of claim **1**, wherein when the wire is in the extended position, the wire, the finger, and the distal end of the inner shaft form a fully closed loop for trapping the suture.

16. A method for securing a suture to a pre-drilled bore, the method comprising:

providing an implant delivery device including a distal end, the distal end being convertible from an open configuration to a closed configuration;

positioning the distal end of the implant delivery device, in the open configuration, proximate the suture;

converting the distal end of the implant delivery device from the open configuration to the closed configuration to encircle the suture in a loop of the closed configuration, the suture being slidable through the loop when the distal end is in the closed configuration;

inserting the distal end of the implant delivery device into the pre-drilled bore;

deploying a cannulated implant, having a threaded outer surface, from the implant delivery device into the pre-drilled bore, the cannulated implant securing the suture between the threaded outer surface and a wall of the pre-drilled bore when the cannulated implant is deployed;

converting the distal end of the implant delivery device from the closed configuration to the open configuration; and

retracting the implant delivery device from the pre-drilled bore.

17. The method of claim **16**, wherein deploying the cannulated implant comprises:

controllably rotating the cannulated implant about a longitudinal implant axis of the cannulated implant.

18. The method of claim **17**, wherein controllably rotating the cannulated implant about a longitudinal implant axis of the cannulated implant comprises:

at a proximal portion of the implant delivery device, imparting a rotation to a cannulated outer shaft of the implant delivery device; and

rotatably coupling a distal end of the cannulated outer shaft to a proximal end of the cannulated implant.

19. The method of claim **16**, wherein converting the distal end of the implant delivery device from the open configuration to the closed configuration comprises:

controllably advancing a portion of a wire from within an inner shaft of the implant delivery device to contact a distally-extending finger at the distal end of the implant delivery device.

20. The method of claim **19**, wherein converting the distal end of the implant delivery device from the closed configuration to the open configuration comprises:

controllably retracting the portion of the wire into the inner shaft.

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