CLAIMS

What is claimed is:

1. A system for use with a subject, comprising:

a catheter device, comprising:

a tube that has:

a distal opening that is configured to be transluminally advanced into the subject, and

a proximal end that defines a proximal opening, and

an extracorporeal unit that is coupled to the proximal end of the tube, defines a deployment position, and comprises a track that leads to the deployment position; and

a series of anchors;

a series of cartridges, each of the cartridges:

holding a respective anchor of the series of anchors,

being coupled to the extracorporeal unit at a respective initial position of a series of initial positions,

while remaining coupled to the extracorporeal unit, being moveable along the track from the respective initial position to the deployment position such that, in the deployment position, the cartridge holds the respective anchor opposite the proximal opening; and

an anchor driver that, for each of the anchors, is configured to:

while the anchor is held opposite the proximal opening by the respective cartridge in the deployment position, engage the anchor, and

advance the anchor distally out of the respective cartridge, through the proximal opening, and through the tube toward the distal opening.

2. The system according to claim 1, wherein the extracorporeal unit includes a barrier movable between a closed state in which the barrier obstructs the proximal opening and an open state, and wherein the anchor driver, for each of the anchors, is configured to:

while the anchor is held opposite the proximal opening by the respective cartridge in the deployment position:

engage the anchor, and

while engaged with the anchor, apply a force to the anchor that transitions the barrier into the open state, and

while the barrier remains in the open state, advance the anchor distally out of the respective cartridge, through the proximal opening, and through the tube toward the distal opening.

3. The system according to claim 2, wherein the force is an engagement verification force that challenges the engagement of the anchor by the anchor driver.

4. The system according to any one of claims 2-3, wherein the force is a proximal pulling force, and wherein the anchor driver, for each of the anchors, is configured to, while engaged with the anchor, apply the proximal pulling force to the anchor.

5. The system according to any one of claims 2-4, wherein the system is configured to define a threshold magnitude of the force, the barrier transitioning into the open state responsively to the force only upon the force exceeding the threshold magnitude.

6. The system according to any one of claims 2-5, wherein, for each of the cartridges:

the cartridge is configured to undergo conformational change in response to the force, and

the anchor driver is configured to transition the barrier into the open state by inducing the conformational change by applying the force to the respective anchor.

7. The system according to any one of claims 2-6, wherein the barrier is biased toward being in the open state.

8. The system according to any one of claims 2-7, wherein the extracorporeal unit comprises a spring-loaded displacement mechanism configured to transition the barrier into the open state responsively to the force applied to the anchor by the anchor driver.

9. The system according to any one of claims 1-8, wherein each of the cartridges is configured to lock to the extracorporeal unit upon arriving at the deployment position.

10. The system according to any one of claims 1-9, wherein each of the cartridges is shaped to be grasped by hand by a human operator and is configured to be moved along the track by hand by the operator.

11. The system according to any one of claims 1-10, wherein:

the catheter device further comprises a port at the proximal opening of the tube, and

the system further comprises a flushing adapter:

comprising a fluid fitting, a nozzle, and a channel therebetween, and

reversibly lockable to the extracorporeal unit in a flushing position in which:

the fluid fitting is accessible from outside of the catheter device, and

the nozzle in fluid communication with the port such that fluid driven into the flushing adapter via the fluid fitting is directed distally through the tube.

12. The system according to claim 11, wherein, in the flushing position, a barrier of the extracorporeal unit is in the open state, and the channel extends distally past the barrier.

13. The system according to claim 11, wherein the flushing position is substantially coincident with the deployment position.

14. The system according to claim 11, wherein the fluid fitting is a Luer fitting.

15. The system according to claim 11, wherein the port comprises a sealing membrane, the anchor driver configured, for each of the anchors, to advance the anchor distally through the membrane and into the tube.

16. The system according to claim 15, wherein, in the flushing position, the nozzle seals with the port proximally from the membrane.

17. The system according to claim 16, wherein, the port has a tapered inner wall that defines a lumen proximal from the membrane, the lumen of the port tapering distally toward the membrane.

18. The system according to claim 17, wherein the nozzle is dimensioned such that, when the flushing adapter is locked to the extracorporeal unit in the flushing position, the nozzle seals against the tapered inner wall proximally from the membrane.

19. The system according to claim 15, wherein the membrane is shaped to define a first aperture through the membrane, a second aperture through the membrane, and a closed slit connecting the first aperture with the second aperture.

20. The system according to claim 19, wherein the first aperture is wider in diameter than the second aperture.

21. The system according to claim 20, wherein the first aperture is 3-10 times larger than the second aperture.

22. The system according to claim 20, wherein:

each of the anchors comprises a tissue-engaging element, and a head that comprises an eyelet, and

the port is arranged such that, for each of the cartridges, while the cartridge is in the deployment position and holds the respective anchor opposite the proximal opening:

the tissue-engaging element of the respective tissue anchor is aligned with the first aperture, thereby defining an anchor-advancement axis from the respective tissue anchor, through the first aperture, and through the tube, and

the eyelet of the respective tissue anchor is aligned with the second aperture.

23. The system according to any one of claims 1-22, wherein:

the system further comprises a platform,

the proximal end of the tube defines a longitudinal axis,

the extracorporeal unit is configured to be mounted on the platform in a manner that facilitates rotation of the extracorporeal unit around the longitudinal axis, and

the extracorporeal unit is rotationally fixed to the tube, such that rotation of the extracorporeal unit around the longitudinal axis rotates the tube.

24. The system according to claim 23, wherein:

the system defines an array of discrete rotational orientations of the extracorporeal unit around the longitudinal axis, and

the extracorporeal unit is configured to be mounted on the platform in a manner that facilitates orienting the extracorporeal unit in each of the discrete rotational orientations.

25. The system according to claim 24, further comprising at least one detent, configured to secure the extracorporeal unit in each of the discrete rotational orientations.

26. The system according to claim 25, wherein the at least one detent is configured to secure the extracorporeal unit in each of the discrete rotational orientations by providing a snap-fit of the extracorporeal unit in each of the discrete rotational orientations.

27. The system according to claim 25, wherein:

the extracorporeal unit defines an array of recesses corresponding to the array of discrete rotational orientations, and

the at least one detent is configured to secure the extracorporeal unit in each of the discrete rotational orientations by, for each of the discrete rotational orientations, protruding into the corresponding recess.

28. The system according to claim 25, wherein:

the system further comprises a bracket, the extracorporeal unit being configured to be mounted on the platform via coupling between the bracket and the platform,

the extracorporeal unit is rotatably coupled to the bracket in a manner that facilitates rotation of the extracorporeal unit around the longitudinal axis, and

the at least one detent is configured to secure the extracorporeal unit in each of the discrete rotational orientations by, while the extracorporeal unit is disposed in any of the discrete rotational orientations, inhibiting rotation of the extracorporeal unit with respect to the bracket.

29. The system according to claim 25, wherein the at least one detent is spring-loaded.

30. The system according to any one of claims 1-29, wherein, for each of the cartridges, a barrier of the extracorporeal unit is configured to transition into a closed state responsively to movement of the cartridge toward the deployment position.

31. The system according to claim 30, wherein, for each of the cartridges, the barrier is configured to transition into the closed state responsively to arrival of the cartridge at the deployment position.

32. The system according to claim 31, wherein, for each of the cartridges, the cartridge is configured to push the barrier toward the closed state upon arrival of the cartridge at the deployment position.

33. The system according to claim 32, wherein, for each of the cartridges, the cartridge:

comprises:

a first piece, and

a second piece that holds the respective anchor,

defines a face that, upon arrival of the cartridge at the deployment position, pushes the barrier toward the closed state, and

is configured such that, while the cartridge remains in the deployment position with the barrier in the closed state, application of a force to the respective anchor displaces the face such that the barrier responsively transitions into an open state.

34. The system according to claim 33, wherein:

the cartridge is configured such that, while the cartridge remains in the deployment position with the barrier in the closed state, application of the force to the respective anchor moves the face proximally, and

the barrier is configured to transition into the open state responsively to the movement of the face proximally.

35. The system according to claim 33, wherein:

the face is defined by the second piece, and

the cartridge is configured such that, while the cartridge remains in the deployment position with the barrier in the closed state, application of the force to the respective anchor displaces the face by sliding the second piece with respect to the first piece.

36. The system according to claim 33, wherein, for each of the cartridges, the cartridge is coupled to the extracorporeal unit via coupling between the first piece and the extracorporeal unit.

37. The system according to claim 33, wherein the second piece is mounted inside the first piece.

38. The system according to claim 37, wherein the first piece is shaped to be grasped by hand by a human operator.

39. The system according to claim 1, wherein, from the deployment position, each of the cartridges is removable such that the deployment position becomes vacant for a successive cartridge of the series.

40. The system according to claim 39, wherein, from the deployment position, each of the cartridges is removable by being removed from the extracorporeal unit.

41. The system according to any one of claims 1-40, wherein the anchor driver is configured to, for each of the anchors, advance the anchor distally out of the respective cartridge, through the proximal opening, and through the tube toward the distal opening while the respective cartridge remains in the deployment position.

42. The system according to claim 41, wherein, for each of the cartridges, the cartridge is configured such that, while (i) the cartridge remains at the deployment position, and (ii) the anchor driver is extended distally beyond the cartridge and through the tube toward the distal opening, the anchor driver inhibits removal of the cartridge from the deployment position.

43. The system according to any one of claims 1-42, wherein:

each of the anchors comprises a tissue-engaging element, and a head that comprises an eyelet, and

the system further comprises a tether:

threaded through the eyelet of each of the anchors,

having a proximal portion that includes a proximal end of the tether, and

having a distal portion that includes a distal end of the tether, the distal end of the tether being advanceable distally through the tube into the subject while the proximal end of the tether remains outside of the subject.

44. The system according to claim 43, wherein:

the tube defines a lateral slit extending proximally from the distal end of the tube, and

the lateral slit is dimensioned to allow the tether, but not the anchors, to exit the tube laterally, proximally from the distal end of the tube.

45. The system according to claim 44, wherein the tube is shaped to define a narrowed inlet into the lateral slit, configured to inhibit but not preclude the tether from distally exiting the lateral slit via the narrowed inlet.

46. The system according to claim 45, wherein the tube comprises a tip frame that maintain the lateral slit and the narrowed inlet.

47. The system according to claim 46, wherein the tip frame is resilient.

48. The system according to claim 43, wherein, for each of the anchors:

the tissue-engaging element defines a central longitudinal axis of the anchor, has a sharpened distal tip, and is configured to be driven into tissue of the subject,

the head is coupled to a proximal end of the tissue-engaging element, and further comprises an interface, configured to be reversibly engaged by the anchor driver, and

the eyelet is mounted so as to be revolvable about the central longitudinal axis of the anchor.

49. The system according to claim 48, wherein, for each of the anchors, the eyelet:

defines an aperture and a slide axis through the aperture,

is disposed laterally from the central longitudinal axis of the anchor thereby defining an eyelet axis that is orthogonal to the central longitudinal axis, and

is mounted so as to be rotatable about the eyelet axis in a manner that constrains the slide axis to be orthogonal to the eyelet axis.

50. The system according to claim 48, wherein, for each of the anchors, the eyelet:

defines an aperture and a slide axis through the aperture,

is disposed laterally from the central longitudinal axis of the anchor thereby defining an eyelet axis that is orthogonal to the central longitudinal axis, and

is mounted so as to be revolvable about the central longitudinal axis while the slide axis remains constrained to be orthogonal to the eyelet axis.

51. The system according to claim 48, wherein the interface is disposed on the central longitudinal axis of the anchor.

52. The system according to claim 48, wherein the tissue-engaging element is helical, defines the central longitudinal axis by extending in a helix around and along the central longitudinal axis, and is configured to be screwed into the tissue of the subject.

53. The system according to claim 48, wherein:

the head comprises a collar that circumscribes the central longitudinal axis, and is rotatably coupled to the tissue-engaging element, and

the eyelet is mounted on the collar and is revolvable around the central longitudinal axis by rotation of the collar about the central longitudinal axis.

54. The system according to claim 43, further comprising a series of tubular spacers, threaded on the tether alternatingly with the anchors.

55. The system according to claim 54, wherein each of the spacers is elastically flexible in deflection.

56. The system according to claim 55, wherein each of the spacers comprises, at each end of the tubular spacer, a rigid ring.

57. The system according to claim 54, wherein each of the spacers resists axial compression.

58. The system according to claim 54, wherein each of the spacers is defined by a helical wire shaped as a coil.

59. The system according to claim 43, wherein the anchor driver, for each of the anchors, is configured to advance the anchor distally out of the respective cartridge, through the proximal opening, and through the tube toward the distal opening, while the eyelet of the anchor remains threaded on the tether.

60. The system according to claim 59, wherein:

the catheter device further comprises a port at the proximal opening of the tube, the port comprising a membrane,

the membrane is shaped to define a first aperture through the membrane, a second aperture through the membrane, and a closed slit connecting the first aperture with the second aperture, and

the port is arranged such that, for each of the anchors, the anchor driver is configured to advance the anchor distally out of the respective cartridge and through the membrane with the tissue-engaging element passing through the first aperture and the tether extending through the second aperture.

61. The system according to claim 43, wherein the catheter device further comprises a tensioner that comprises a spring-loaded winch, coupled to the proximal portion of the tether, and configured to maintain tension on the tether.

62. A system for use with a subject, comprising:

a catheter device, comprising:

a tube that has a proximal opening, and a distal opening that is configured to be transluminally advanced into the subject, and

an extracorporeal unit that comprises a track that leads to a deployment position;

a first cartridge holding a first anchor and being coupled to the extracorporeal unit and, while remaining coupled to the extracorporeal unit, being moveable along the track from a first initial position to the deployment position such that the first cartridge holds the first anchor opposite the proximal opening;

a second cartridge holding a second anchor and being coupled to the extracorporeal unit and, while remaining coupled to the extracorporeal unit, being moveable along the track from a second initial position to the deployment position such that the second cartridge holds the second anchor opposite the proximal opening; and

an anchor driver that is:

couplable to the first anchor while the first anchor is held by the first cartridge opposite the proximal opening,

configured to advance the first anchor distally out of the first cartridge through the proximal opening and through the tube,

subsequently couplable to the second anchor while the second anchor is held by the second cartridge opposite the proximal opening, and

configured to advance the second anchor distally out of the second cartridge through the proximal opening and through the tube toward the first anchor.

63. The system according to claim 62, wherein the extracorporeal unit comprises a barrier movable between a closed state in which the barrier obstructs the proximal opening and an open state, and wherein the anchor driver is:

configured to, while coupled to the first anchor and while the barrier is in the open state, advance the first anchor distally out of the first cartridge through the proximal opening and through the tube,

subsequently, configured to, while coupled to the second anchor and while the barrier is in the open state, advance the second anchor distally out of the second cartridge through the proximal opening and through the tube toward the first anchor.

64. The system according to claim 63, wherein the driver is configured to advance the first anchor distally out of the first cartridge through the proximal opening and through the tube while:

the first cartridge is in the deployment position,

the barrier is in the open state, and

the second cartridge remains in the second initial position.

65. The system according to any one of claims 62-64, wherein each of the first cartridge and the second cartridge is configured to lock to the extracorporeal unit upon arriving at the deployment position.

66. The system according to any one of claims 62-65, wherein each of the first cartridge and the second cartridge is shaped to be grasped by hand by a human operator and is configured to be moved along the track by hand by the human operator, and wherein each of the first cartridge and the second cartridge is removable from the deployment position by being removed from the extracorporeal unit.

67. The system according to any one of claims 62-66, further comprising a third cartridge holding a third anchor and being coupled to the extracorporeal unit and, while remaining coupled to the extracorporeal unit, being moveable along the track from a third initial position to the deployment position such that the third cartridge holds the third anchor opposite the proximal opening.

68. The system according to any one of claims 62-67, wherein the first anchor comprises a first tissue-engaging element and a first head comprising a first eyelet, and the second anchor comprises a second tissue-engaging element and a second head comprising a second eyelet.

69. The system according to claim 68, further comprising a tether threaded through the first eyelet and the second eyelet, the tether having a proximal portion that includes a proximal end of the tether and having a distal portion that includes a distal end of the tether, the distal end of the tether being advanceable distally through the tube into the subject while the proximal end of the tether remains outside of the subject.

70. The system according to claim 69, wherein the anchor driver is configured to advance the first anchor distally out of the first cartridge, through the proximal opening, and through the

tube, while the first eyelet of the first anchor remains threaded on the tether, and wherein the anchor driver is configured to advance the second anchor distally out of the second cartridge, through the proximal opening, and through the tube, while the second eyelet of the second anchor remains threaded on the tether.

71. The system according to claim 70, wherein the catheter device further comprises a tensioning device configured to maintain tension on the tether during advancement of the first anchor and advancement of the second anchor.

72. The system according to claim 71, wherein the tensioning device comprises a spring and a spool, the spool coupled to the spring such that rotation of the spool in a first direction applies stress to the spring, and wherein the proximal portion of the tether is wound around the spool such that advancing of the distal portion of the tether distally through the tube rotates the spool in the first direction.

73. A system, for use with a subject, the system comprising:

a catheter device, comprising:

a tube that has:

a distal opening that is configured to be transluminally advanced to a tissue of the subject, and

a proximal portion, and

an extracorporeal unit that is coupled to the proximal portion of the tube;

a series of anchors, each of the anchors comprising:

a tissue-engaging element, and

a head, coupled to a proximal end of the tissue-engaging element, and comprising an interface and an eyelet;

a tether, threaded through the eyelet of each of the anchors; and

an anchor driver that, for each of the anchors, is configured to:

engage the interface of the anchor, and

while engaged with the anchor, advance the anchor distally through the tube toward the distal opening, and drive the tissue-engaging element into the tissue.

74. The system according to claim 73, wherein:

the system defines an array of discrete rotational orientations of the extracorporeal unit around longitudinal tube axis of the proximal portion of the tube,

~~the extracorporeal unit is configured to be mounted on a platform in a manner that facilitates rotation of the extracorporeal unit around the longitudinal tube axis so as to become oriented in any of the discrete rotational orientations, and~~

~~the extracorporeal unit is rotationally fixed to the tube, such that rotation of the extracorporeal unit around the longitudinal tube axis rotates the tube.~~

~~75. The system according to any one of claims 73-74, wherein:~~

~~the tube defines a lateral slit extending proximally from the distal opening of the tube, and~~

~~the lateral slit is dimensioned to allow the tether, but not the anchors, to exit the tube laterally, proximally from the distal opening of the tube.~~

~~76. The system according to claim 75, wherein the tube is shaped to define a narrowed inlet into the lateral slit, configured to inhibit but not preclude the tether from distally exiting the lateral slit via the narrowed inlet.~~

~~77. The system according to claim 76, wherein the tube comprises a tip frame that maintain the lateral slit and the narrowed inlet.~~

~~78. The system according to claim 77, wherein the tip frame is resilient.~~

~~79. The system according to any one of claims 73-78, further comprising at least one detent, configured to secure the extracorporeal unit in each of the discrete rotational orientations.~~

~~80. The system according to claim 79, wherein the at least one detent is spring-loaded.~~

~~81. The system according to claim 79, wherein the at least one detent is configured to secure the extracorporeal unit in each of the discrete rotational orientations by providing a snap-fit of the extracorporeal unit in each of the discrete rotational orientations.~~

~~82. The system according to claim 79, wherein:~~

~~the extracorporeal unit defines an array of recesses corresponding to the array of discrete rotational orientations, and~~

~~the at least one detent is configured to secure the extracorporeal unit in each of the discrete rotational orientations by, for each of the discrete rotational orientations, protruding into the corresponding recess.~~

~~83. The system according to claim 79, wherein:~~

~~the system further comprises a bracket, the extracorporeal unit being configured to be mounted on a platform via coupling between the bracket and the platform,~~

~~the extracorporeal unit is rotatably coupled to the bracket in a manner that facilitates rotation of the extracorporeal unit around a longitudinal tube axis of the proximal portion of the tube, and~~

~~the at least one detent is configured to secure the extracorporeal unit in each of the discrete rotational orientations by, while the extracorporeal unit is disposed in any of the discrete rotational orientations, inhibiting rotation of the extracorporeal unit with respect to the bracket.~~

~~84. The system according to any one of claims 73-83, further comprising a series of tubular spacers, threaded on the tether alternately with the anchors.~~

~~85. The system according to claim 84, wherein each of the spacers is elastically flexible in deflection.~~

~~86. The system according to claim 84, wherein each of the spacers comprises, at each end of the tubular spacer, a rigid ring.~~

~~87. The system according to claim 84, wherein each of the spacers resists axial compression.~~

~~88. The system according to claim 84, wherein each of the spacers is defined by a helical wire shaped as a coil.~~

~~89. The system according to any one of claims 73-88, wherein, for each of the anchors:~~

~~the tissue-engaging element defines a central longitudinal anchor axis of the anchor, and~~

~~the eyelet is mounted so as to be revolvable about the central longitudinal anchor axis.~~

~~90. The system according to claim 89, wherein, for each of the anchors, the eyelet:~~

~~defines an aperture and a slide axis through the aperture,~~

~~is disposed laterally from the central longitudinal anchor axis thereby defining an eyelet axis that is orthogonal to the central longitudinal anchor axis, and~~

~~is mounted so as to be rotatable about the eyelet axis in a manner that constrains the slide axis to be orthogonal to the eyelet axis.~~

~~91. The system according to claim 89, wherein, for each of the anchors, the eyelet:~~

~~defines an aperture and a slide axis through the aperture,~~

~~is disposed laterally from the central longitudinal anchor axis thereby defining an eyelet axis that is orthogonal to the central longitudinal axis, and~~

~~is mounted so as to be revolvable about the central longitudinal anchor axis while the slide axis remains constrained to be orthogonal to the eyelet axis.~~

92. The system according to claim 89, wherein the interface is disposed on the central longitudinal axis of the anchor.

93. The system according to claim 89, wherein the tissue-engaging element is helical, defines the central longitudinal anchor axis by extending in a helix around and along the central longitudinal anchor axis, and is configured to be screwed into the tissue of the subject.

94. A system, for use with a subject, the system comprising:

a catheter device, comprising:

a tube that has:

a distal opening that is configured to be transluminally advanced to a tissue of the subject, and

a proximal portion that defines a longitudinal tube axis, and

an extracorporeal unit that is coupled to the proximal portion of the tube; and

a platform,

wherein:

the system defines an array of discrete rotational orientations of the extracorporeal unit around the longitudinal tube axis,

the extracorporeal unit is configured to be mounted on the platform in a manner that facilitates rotation of the extracorporeal unit around the longitudinal tube axis so as to become oriented in any of the discrete rotational orientations, and

the extracorporeal unit is rotationally fixed to the tube, such that rotation of the extracorporeal unit around the longitudinal tube axis rotates the tube.

95. The system according to claim 94, further comprising a series of anchors, each of the anchors being advanceable through the tube, and comprising:

a tissue-engaging element, and

a head coupled to a proximal end of the tissue-engaging element.

96. The system according to claim 95, wherein the head of each of the anchors and comprises an interface and an eyelet, and wherein the system further comprises a tether, threaded through the eyelet of each of the anchors.

97. The system according to claim 96, further comprising an anchor driver that, for each of the anchors, is configured to engage the interface of the anchor, and while engaged with the anchor, advance the anchor distally through the tube toward the distal opening, and drive the tissue-engaging element into the tissue.

98. A system, for use with a subject, the system comprising:

a catheter device, comprising:

a tube that has:

a proximal portion including a proximal end,

a distal portion that is configured to be transluminally advanced to a tissue of the subject, and

an intermediate portion extending between the proximal portion and the distal portion, and

an extracorporeal unit that is coupled to the proximal portion of the tube;

a series of anchors, each of the anchors comprising:

a tissue-engaging element, and

a head, coupled to a proximal end of the tissue-engaging element, and comprising an interface and an eyelet;

a tether, threaded through the eyelet of each of the anchors;

an anchor driver that, for each of the anchors, is configured to:

engage the interface of the anchor, and

while engaged with the anchor, advance the anchor distally through the tube toward the distal portion, and drive the tissue-engaging element into the tissue,

wherein:

the distal portion defines a lumen, a distal opening, and a lateral slit extending proximally from the distal opening,

each of the anchors is dimensioned to be advanced by the anchor driver distally out of the lumen via the distal opening,

the lateral slit is dimensioned to allow the tether, but not the anchor, to exit the lumen laterally through the lateral slit, and

the distal portion is rotatably coupled to the intermediate portion such that the lateral slit is revolvable about the lumen.

99. The system according to claim 98, wherein the distal portion is shaped to define a narrowed inlet into the lateral slit, configured to inhibit but not preclude the tether from distally exiting the lateral slit via the narrowed inlet.

100. A tissue anchor comprising:

a helical tissue-engaging element:

having a proximal turn, and a distal turn that defines a sharpened distal tip, and

extending helically around a central anchor axis of the tissue anchor; and

a head, comprising:

a core, disposed on the central longitudinal axis, and

a flange, fixed to the core, and having a proximal facing surface, the proximal turn lying on the proximal facing surface; and

a cap, fixed to the core in a manner that secures the tissue-engaging element to the head by sandwiching the proximal turn against the proximal facing surface of the flange.

101. The tissue anchor according to claim 100, wherein the flange is a first flange, the cap is shaped to define a second flange, and the cap is fixed to the core in a manner that secures the tissue engaging element to the head by sandwiching the proximal turn between the second flange and the proximal facing surface of the first flange.

102. A method for manufacturing a tissue anchor, the anchor including a head and helical tissue engaging element, the method comprising:

placing a proximal turn of the helical tissue engaging element on a proximal facing surface of a flange of the head, the head including a core disposed on a central anchor axis of the tissue anchor, and the tissue-engaging element extending helically around the central anchor axis and having a distal turn that defines a sharpened distal tip, and

sandwiching the proximal turn against the proximal facing surface of the flange by fixing a cap to the core.

103. The method according to claim 102, wherein the flange is a first flange, the cap is shaped to define a second flange, and sandwiching the proximal turn against the proximal facing surface of the flange comprises sandwiching the proximal turn between the second flange and the proximal facing surface of the first flange.

104. A system, for use with a subject, the system comprising a catheter device that comprises:

a tube that has:

a proximal portion including a proximal end, and

a distal portion that is configured to be transluminally advanced to a tissue of the subject;

an extracorporeal unit that is coupled to the proximal portion of the tube; and

a fluoroscopic guide, comprising:

a flap, having:

a tip,

a root at which the flap is pivotably coupled to the distal portion of the tube in a manner in which the flap is deflectable with respect to the tube between:

a retracted state in which the flap is substantially parallel with the tube, and

an extended state in which the flap extends laterally from the tube, and

an intermediate portion extending between the tip and the root, the intermediate portion being:

radiopaque, and

flexible such that pressing on the intermediate portion changes a curvature of the intermediate portion, and

a control rod, extending from the distal portion of the tube to the tip of the flap such that:

advancement of the control rod deflects the flap toward the extended state by pushing the tip of flap, and

retraction of the control rod deflects the flap toward the retracted state by pulling the tip of the flap.

105. A system, comprising an anchor for use with tissue of a subject, the anchor comprising:

a case, having a tissue-facing side that defines a tissue-facing opening from inside the case to outside the case; and

a tissue-engaging element:

shaped to define a helix that has multiple turns around an axis;

axially compressed within the case, and positioned such that rotation of the tissue-engaging element about the axis feeds the helix distally out of the tissue-facing opening; and

configured to be screwed into the tissue, and to anchor the case to the tissue, the tissue-facing side serving as an anchor head of the anchor.

106. The system according to claim 105, wherein the case side defines grips on the tissue-facing side, such that the screwing of the tissue-engaging element into the tissue presses the grips against the tissue.

107. The system according to any one of claims 105, wherein the anchor is configured such that screwing of the tissue-engaging element into the tissue moves a proximal part of the tissue-engaging element toward the tissue-facing side; and wherein:

the case further has a driver side opposite the tissue-facing side, and that defines a driver opening that provides access to the interface from outside the case, and

the anchor is configured such that screwing of the tissue-engaging element into the tissue moves the proximal part of the tissue-engaging element away from the driver side.

108. An apparatus comprising a tissue anchor for use with an anchor driver, the anchor comprising:

a tissue-engaging element defining a central longitudinal axis of the anchor, having a sharpened distal tip, and configured to be driven into tissue of a subject; and

an anchor head, coupled to a proximal end of the tissue-engaging element, the anchor head comprising:

an interface, configured to be reversibly engaged by the anchor driver, and

an eyelet:

defining an aperture and a slide axis through the aperture,

disposed laterally from the central longitudinal axis thereby defining an eyelet axis that is orthogonal to the central longitudinal axis, and

mounted such that the eyelet is rotatable about the eyelet axis in a manner that constrains the slide axis to be orthogonal to the eyelet axis.

109. The apparatus according to claim 108, wherein the apparatus comprises an implant that comprises the anchor, and a tether threaded through the aperture; and wherein:

the anchor is a first anchor of the implant,

the implant further comprises:

a second anchor, and

a spacer that is tubular, having two spacer ends and a spacer lumen therebetween, and

the spacer is threaded on the tether between the first anchor and the second anchor, with the tether passing through the spacer lumen.

110. The apparatus according to any one of claims 108-109, further comprising the anchor driver; and wherein:

the anchor driver has a driver head that has an introduction state and a locking state,

the anchor head is shaped to define a proximal opening via which the interface is accessible by the driver head while the driver head is in the introduction state, and

the anchor driver is configured to lock the driver head to the interface by transitioning the driver head into the locking state by moving a part of the driver head laterally.

111. A system comprising an implant for use in a heart of a subject, the implant comprising:

a first anchor;

a second anchor;

at least one tether coupling the first anchor to the second anchor; and

a tensioner, coupled to the at least one tether between the first anchor and the second anchor, and comprising:

a spring; and

a restraint, restraining the spring in an elastically-deformed shape of the spring, wherein:

the restraint is bioresorbable, such that after implantation of the implant within the heart, disintegration of the restraint releases the spring from the restraint,

the spring is configured to, upon release from the restraint, automatically move away from the elastically-deformed state toward a second shape, and

the coupling of the spring to the at least one tether is such that the movement of the spring away from the elastically-deformed state toward the second shape pulls, via the at least one tether, the first anchor and the second anchor toward each other.

112. An apparatus, comprising an anchor for use with tissue of a subject, the anchor comprising:

a sharpened distal tip;

a hollow body proximal from the distal tip, and shaped to define:

a chamber,

a lateral wall around the chamber, an anchor axis of the anchor passing through the chamber and the tip, and

two ports in the lateral wall; and

a spring, comprising an elongate element having two ends and defining a loop therebetween, at least the loop being disposed within the chamber,

wherein the anchor:

has a first state in which the spring is constrained by the lateral wall, and

is transitionable from the first state into a second state in which, relative to the first state, the elongate element is under less strain, and the ends are disposed further apart from each other, each of the ends protruding laterally from the hollow body via a respective one of the ports.

113. An apparatus for use with tissue of a heart of a subject, the apparatus comprising:

a tool, transluminally advanceable to the heart and comprising a tube, having a distal end that defines an opening; and

an anchor, disposed at least partly within the tube, and comprising a tissue-engaging element, the anchor being configured to be anchored to the tissue by the tissue-engaging element being driven into the tissue;

a driver, extending through at least part of the tube, a distal end of the driver being reversibly engaged with the anchor within the tube, the driver being configured to drive the tissue-engaging element out of the opening and into the tissue, while the opening is disposed within the tissue; and

wherein the tool is configured to, while the anchor remains disposed at least partly within the tube, penetrate the distal end of the tube into the tissue such that the opening becomes submerged within the tissue.

114. A system for use with tissue of a heart of a subject, the system comprising a tissue anchor that comprises:

a head:

having a tissue-facing side, shaped to define a plurality of grips, and

an opposing side that defines an eyelet; and

multiple tissue-engaging elements, disposed laterally from the grips:

each having a sharpened tip,

each having:

a delivery state in which the tissue-engaging element is configured to be driven linearly into the tissue until the grips contact the tissue, and

a gripping state, and

collectively configured such that, while the multiple tissue-engaging elements are disposed within the tissue with the grips contacting the tissue, transitioning of the tissue-engaging elements toward the gripping state brings the tips toward each other and presses the grips against the tissue.

115. A system for use with tissue of a heart of a subject, the system comprising:

an anchor;

a tether, coupled to the anchor, the anchor being configured to be anchored to the tissue such that the tether extends proximally from the anchor;

a tether-handling device, comprising:

a housing, shaped to define a passage therethrough, the tether extending through the passage in a manner that facilitates transluminal sliding of the housing distally over and along the tether to the anchor;

a clamp, coupled to the housing, and biased to clamp onto the tether within the passage in a manner that inhibits sliding of the housing with respect to the tether; and

an arm, extending proximally from the housing, and comprising:

a conduit, shaped to receive a portion of the tether proximally from the housing, and

a lever, coupling the conduit to the housing, and biased to place the conduit in an offset position with respect to the passage; and

a tool, comprising a tube,

wherein:

the system has a delivery state in which the tool:

is coupled to the tether-handling device, with the tube disposed:

within the passage in a manner that inhibits the clamp from clamping, and

within the conduit in a manner that constrains the conduit in an in-line position with respect to the passage, and

is configured to transluminally advance the tether-handling device distally over and along the tether toward the anchor.

116. An apparatus for use with a tether, the apparatus comprising a clamp, comprising:

a chuck, having a longitudinal axis, and comprising:

a sleeve, circumscribing the longitudinal axis, and having a tapered inner surface, and

a collet, disposed within the sleeve, and dimensioned to receive the tether therethrough; and

a spring, axially pushing the collet against the tapered inner surface such that the collet is squeezed medially by the sleeve.

117. A system comprising an implant configured to be implanted in a heart of a subject, the implant comprising:

a tether;

anchors slidably coupled to the tether, and configured to anchor the tether to tissue of the heart;

a spring, having a resting state, and coupled to the tether in a manner in which movement of the spring toward the resting state applies tension to the tether; and

a restraint:

coupled to the spring in a manner that inhibits the spring from moving toward the resting state,

comprising a material that is configured to disintegrate within the heart, and

configured such that disintegration of the material reduces the inhibition of the spring by the restraint.

118. A system, for use with tissue of a heart of a subject, the system comprising:

an anchor, comprising:

a tissue-engaging element having a sharpened distal tip, and configured to anchor the anchor to the tissue by being driven into the tissue; and

an anchor head, coupled to a proximal end of the tissue-engaging element, and comprising an interface; and

an anchor-handling assembly, comprising:

a sleeve having a distal portion that includes a distal end of the sleeve, the distal portion being transluminally advanceable to the anchor anchored to the tissue, and the distal end being dimensioned to snugly fit over the anchor head; and

a tool, comprising:

a flexible shaft; and

a tool head:

coupled to a distal end of the flexible shaft,

comprising jaws that are biased to assume an open state, and that are reversibly squeezable into a closed state, and

dimensioned, relative to an inner dimension of the distal portion of the sleeve, such that disposition of the tool head in the distal portion of the sleeve squeezes the jaws into the closed state,

wherein the tool is configured to:

advance the tool head distally through the sleeve to the distal portion,

while the jaws remain in the closed state, lock the jaws to the interface, and

while the jaws remain locked to the interface, apply a de-anchoring force to the anchor head.

119. A system for use with a tether secured along tissue of a heart of a subject, the system comprising:

an anchor comprising:

a tissue-engaging element having a sharpened distal tip; and

a head, coupled to a proximal part of the tissue-engaging element, and comprising a shackle having a reversibly openable opening; and

an anchor-handling assembly, transluminally advanceable to the heart, and comprising:

a driver, configured to drive the tissue-engaging element into the tissue; and

a link-tool, configured to, within the heart, temporarily open the opening and pass the tether laterally through the opening.

120. An apparatus comprising a tissue anchor, the anchor comprising:

a tissue-engaging element defining a central longitudinal axis of the anchor, having a sharpened distal tip, and configured to be driven into tissue of a subject; and

an anchor head, coupled to a proximal end of the tissue-engaging element, the anchor head comprising:

a stock,

a ball joint, and

an eyelet, coupled to the stock via the ball joint.

121. The apparatus according to claim 120, wherein:

the ball joint comprises a socket, and a bearing stud,

the bearing stud defines a ball at a first end of the stud, the ball disposed within the socket,

a second end of the stud defines the eyelet, and

the ball joint defines:

a spherical sector of deflection within which the ball joint allows deflection of the bearing stud into any angular disposition with respect to the socket, and

a deflection plane on which the ball joint allows deflection of the bearing stud beyond the spherical sector of deflection, outside of the deflection plane the ball joint inhibiting deflection of the bearing stud beyond spherical sector of deflection.

122. An apparatus comprising a tissue anchor, the anchor comprising:

a tissue-engaging element defining a central longitudinal axis of the anchor, having a sharpened distal tip, and configured to be driven into tissue of a subject; and

an anchor head, comprising:

a stock, coupled to a proximal end of the tissue-engaging element,

a driver interface coupled to the stock, and

an eyelet, hingedly coupled to the stock such that the eyelet is pivotable over the driver interface.

123. A method, comprising:

to an implant that is coupled to a heart of a subject, transluminally advancing an elongate tool that includes a holder and a cutter, the implant including:

a tether under tension, and

a stopper locking the tension in the tether by being locked to a first portion of the tether;

securing the stopper to the holder; and

while the stopper remains secured to the holder and locked to the first portion of the tether:

relieving the tension on the tether by cutting the tether with the cutter; and

withdrawing the tool, the stopper, and the first portion of the tether from the subject while leaving a second portion of the tether coupled to the heart.

124. A method, comprising:

transluminally advancing an elongate tool to a tether that is under tension and disposed within a heart of a subject, the elongate tool including a holder and a cutter;

securing a first portion of the tether to the holder; and

while the first portion of the tether remains secured to the holder:

relieving the tension on the tether by cutting the tether with the cutter, thereby separating the first portion of the tether from a second portion of the tether; and

withdrawing the tool and the first portion of the tether from the subject while leaving the second portion of the tether coupled to the heart.

125. Apparatus, comprising a tissue anchor, the anchor comprising:

a revolute joint, defining a hinge axis;

a first arm, defining:

a first coupling, and

a first hook that curves about and away from the hinge axis, terminating in a first tip, the curving of the first hook being in a first direction about the hinge axis; and

a second arm, hingedly coupled to the first arm via the revolute joint, and defining:

a second coupling, and

a second hook that curves about and away from the hinge axis, terminating in a second tip, the curving of the second hook being in a second direction about the hinge axis, the second direction being opposite to the first direction,

wherein the hinged coupling of the second arm to the first arm is such that the anchor is transitionable between:

an open state in which:

the first arm is in a first rotational position about the hinge axis;

the first hook and the second hook define a space therebetween,

the first tip and the second tip define therebetween a gap into the space, and

the first coupling and the second coupling are disengaged from each other, and

a closed state in which:

the first arm is in a second rotational position about the hinge axis;

the gap is smaller than in the open state; and

the first coupling and the second coupling are engaged with each other, the engagement between the first coupling and the second coupling inhibiting the anchor from transitioning out of the closed state.

126. An apparatus for use with tissue of a heart, the apparatus comprising:

a tether; and

a tissue anchor comprising:

a stem,

an arm,

a hinge, the arm being coupled to a distal end of the stem via the hinge, and

a head coupled to a proximal part of the stem, the tether being slidably coupled to the head, and the stem having an intermediate part between the distal end and the proximal part,

wherein:

the anchor is anchorable into the tissue by advancing into the tissue, in succession, a first side of the arm, the hinge, and the intermediate part of the stem, such that stem extends, from the distal end and the hinge within the tissue, to the proximal part above the tissue,

the arm is pivotable about the hinge within the tissue such that the anchor is transitionable, within the tissue, toward a restraining state in which the arm extends transversally across the distal end of the stem, and

the head is configured to sandwich the tissue between the arm and the head by being moved distally along the stem toward the hinge.

127. A method for implanting an implant into tissue of a heart of a subject, the method comprising:

into the subject, introducing a tissue anchor including a stem, a head coupled to a proximal part of the stem, an arm, and a hinge via which the arm is coupled to the stem, the stem having an intermediate part between the distal end and the proximal part,

toward the heart, transluminally advancing the anchor along a tether with the head sliding over the tether;

advancing into the tissue, in succession, a first side of the arm, the hinge, and the intermediate part of the stem, such that a proximal part of the stem extends above the tissue;

within the tissue, transitioning the anchor toward a restraining state thereof by pivoting the arm about the hinge such that the arm extends transversally across the distal end of the stem; and

subsequently, sandwiching the tissue between the arm and the head by moving the head distally along the stem toward the hinge.

128. An implant comprising:

a tether;

a first anchor and a second anchor, each of the first and second anchors comprising:

a head, slidably coupled to the tether, and

a tissue-engaging element, configured to anchor the anchor and the tether to the tissue; and

a tubular spacer defining a lumen along a spacer axis, and having:

a primary region that is flexible in deflection; and

~~at each end of the primary region, a secondary region that is less flexible in deflection than the primary region, the lumen extending through the primary region and both secondary regions,~~

~~wherein the tubular spacer is threaded onto the tether between the first anchor and the second anchor, by the tether passing through the lumen.~~

~~129. A system, for use with a subject, the system comprising:~~

~~a delivery tool, percutaneously advanceable into the subject, and having a cavity; and~~

~~a stopper comprising:~~

~~a first element comprising a first plate that defines a first passageway therethrough;~~

~~a second element comprising a second plate that defines a second passageway therethrough; and~~

~~a torsion bar, connecting the first plate to the second plate in a manner in which:~~

~~the torsion bar biases the stopper toward a grip state in which the first passageway and the second passageway are offset with respect to each other, and~~

~~the stopper is dimensioned such that, while the stopper is disposed in the cavity, the delivery tool retains the stopper in an open state, the stopper being transitionable into the open state by increasing stress on the torsion bar and alignment between the first passageway and the second passageway.~~

1. A system for use with a subject, comprising:

a catheter device, comprising:

a tube that has:

a distal opening that is configured to be transluminally advanced into the subject, and

a proximal end that defines a proximal opening, and

an extracorporeal unit that is coupled to the proximal end of the tube; and

a series of anchors;

a series of cartridges arranged along the extracorporeal unit, each of the cartridges:

having an initial position in which the cartridge holds a respective anchor of the series of anchors,

while remaining coupled to the extracorporeal unit, being moveable from the initial position to a deployment position; and

an anchor driver that is configured to, for each of the anchors, sequentially:

engage the anchor, and

while the respective cartridge is in the deployment position, move the anchor out of the respective cartridge, through the proximal opening, and through the tube toward the distal opening.

2. The system according to claim 1, wherein:

the proximal end of the tube defines a tube axis, and

the series of cartridges is arranged in a row that defines a cartridge axis, the cartridge axis being parallel with the tube axis.

3. The system according to claim 1, wherein, for each of the anchors:

the respective cartridge is configured to restrain the anchor therein,

the anchor driver is configured to, while engaged with the anchor, apply a proximal pulling force to the anchor, and

the respective cartridge is configured to, upon the proximal pulling force exceeding a threshold magnitude, responsively undergo a conformational change that allows the anchor driver to move the anchor out of the respective cartridge.

4. The system according to claim 1, wherein, for each of the anchors:

the respective cartridge comprises a first piece and a second piece,

the anchor driver is configured to, while engaged with the anchor, apply a proximal pulling force to the anchor, and

the respective cartridge is configured such that, upon the proximal pulling force exceeding a threshold magnitude, the second piece responsively slides with respect to the first piece in a manner that allows the anchor driver to move the anchor out of the respective cartridge.

5. The system according to claim 1, wherein:

the catheter device further comprises a port at the proximal opening of the tube, and

the system further comprises a flushing adapter:

comprising a fluid fitting, a nozzle, and a channel therebetween, and

reversibly lockable to the extracorporeal unit in a flushing position in which:

the fluid fitting is accessible from outside of the catheter device, and

the nozzle in fluid communication with the port such that fluid driven into the flushing adapter via the fluid fitting is directed distally through the tube.

6. The system according to claim 5, wherein the fluid fitting is a Luer fitting.

7. The system according to claim 5, wherein the port comprises a sealing membrane, the anchor driver configured, for each of the anchors, to advance the anchor distally through the membrane and into the tube.

8. The system according to claim 7, wherein, in the flushing position, the nozzle seals with the port proximally from the membrane.

9. The system according to claim 8, wherein, the port has a tapered inner wall that defines a lumen proximal from the membrane, a lumen of the port tapering distally toward the membrane.

10. The system according to claim 1, wherein each of the cartridges is removable from the extracorporeal unit.

11. The system according to claim 1, wherein the anchor driver is configured to, for each of the anchors, move the anchor out of the respective cartridge, through the proximal opening, and through the tube toward the distal opening while the respective cartridge remains in the deployment position.

12. The system according to claim 1, wherein:

each of the anchors comprises a tissue-engaging element, and a head that comprises an eyelet, and

the system further comprises a tether:

threaded through the eyelet of each of the anchors,

having a proximal portion that includes a proximal end of the tether, and

having a distal portion that includes a distal end of the tether, the distal end of the tether being advanceable distally through the tube into the subject while the proximal end of the tether remains outside of the subject.

13. The system according to claim 12, wherein, for each of the anchors:

the tissue-engaging element defines a central longitudinal axis of the anchor, has a sharpened distal tip, and is configured to be driven into tissue of the subject,

the head is coupled to a proximal end of the tissue-engaging element, and further comprises an interface, configured to be reversibly engaged by the anchor driver, and

the eyelet is mounted so as to be revolvable, with respect to the interface, about the central longitudinal axis of the anchor.

14. The system according to claim 13, wherein the eyelet is mounted so as to be pivotable with respect to the longitudinal axis of the anchor.

15. The system according to claim 14, wherein the eyelet is mounted so as to be pivotable over the interface.

16. The system according to claim 13, wherein the interface is disposed on the central longitudinal axis of the anchor.

17. The system according to claim 13, wherein the tissue-engaging element defines the central longitudinal axis by extending in a helix around and along the central longitudinal axis, and is configured to be screwed into the tissue of the subject.

18. The system according to claim 17, wherein the tissue-engaging element is configured to be screwed into the tissue such that a distal portion of the helix enters the tissue prior to a proximal portion of the helix, the distal portion having a greater pitch than the proximal portion.

19. The system according to claim 13, wherein:

the head comprises a collar that circumscribes the central longitudinal axis, and is rotatably coupled to the interface, and

the eyelet is mounted on the collar and is revolvable around the central longitudinal axis by rotation of the collar about the central longitudinal axis.

20. The system according to claim 12, further comprising a series of tubular spacers, threaded on the tether alternatingly with the anchors.

21. The system according to claim 20, wherein each of the spacers is elastically flexible in deflection.

22. The system according to claim 20, wherein each of the spacers resists axial compression.

23. The system according to claim 20, wherein each of the spacers is defined by a helical wire shaped as a coil.

24. The system according to claim 12, wherein the anchor driver, for each of the anchors, is configured to move the anchor out of the respective cartridge, through the proximal opening, and through the tube toward the distal opening, while the eyelet of the anchor remains threaded on the tether.

25. The system according to claim 12, wherein the catheter device further comprises a tensioner that comprises a spring-loaded winch, coupled to the proximal portion of the tether, and configured to maintain tension on the tether.