

have a pattern and shape that incorporates both longitudinal and transverse cuts forming teeth and grooves in the hollow tube.

[0034] The coiled docking device can include a skeleton or core, and a distal end of the skeleton or core can have a rectangular cross-section and a distal ring-shaped tip.

[0035] The coiled docking device can include a skeleton or core, and at least one end of the skeleton or core can have a ball-shaped tip.

[0036] In one embodiment, a docking device for docking a prosthetic valve at a native valve of a heart is provided that can include any of the features and components described with respect to the docking devices above and elsewhere herein. For example, it can include or be a coiled docking device having an end portion with a central axis. The end portion of the docking device can be configured such that a retrieval suture connected to the end portion will be biased to cause a line of force applied by tension to the retrieval suture to be aligned with the central axis.

[0037] Methods of retrieving a coiled docking device can comprise pulling a retrieval line to pull an end portion of a coiled docking device against a pusher device and/or into a delivery catheter. The end portion of the coiled docking device can be configured as any of the end portions described above or elsewhere herein. For example, the end portion can be configured to bias the retrieval line to align a tension force applied by said pulling with a central axis of the end portion of the coiled docking device. The methods can include drawing pusher device and/or the end portion of the coiled docking device into a delivery catheter.

BRIEF DESCRIPTION OF THE DRAWINGS

[0038] Further features and advantages of the invention will become apparent from the description of embodiments using the accompanying drawings. In the drawings:

[0039] Fig. 1 shows a schematic cross-sectional view of a human heart;

[0040] Fig. 2 shows a schematic top view of a mitral valve annulus of a heart;

WHAT IS CLAIMED IS:

1. A system for implanting a docking device at a native valve, the system comprising:
 - a delivery catheter;
 - an elongated coiled docking device having an end portion;
 - a pusher device having a central lumen, wherein the pusher device is disposed in the delivery catheter;
 - a retrieval line that extends through the central lumen of the delivery catheter and is coupled to the end portion of the coiled docking device;
 - wherein the system is configured such that pulling the retrieval line pulls the end portion of the coiled anchor against the pusher device; and
 - wherein the end portion and retrieval line are configured and coupled such that a tension force from the pulling is biased to be substantially aligned with a central axis of the end portion of the coiled docking device.
2. The system of claim 1, wherein the end portion is configured to align at least a lengthwise portion of the retrieval line along the central axis.
3. The system of claim 1, wherein the retrieval line extends through a central passage at a tip of the end portion of the docking device, and wherein the central passage is aligned with the central axis.
4. The system of claim 1, wherein the docking device further comprises a spherical tip.
5. The system of claim 4, wherein the spherical tip receives the retrieval line through a passage that is aligned with central axis of the end portion of the coiled docking device.
6. The system of claim 5, wherein the spherical proximal tip comprises an annular groove in a transition portion of the spherical proximal tip.

7. The system of claim 1, wherein a distal end of the pusher device is configured to engage a spherical surface at the end portion of the coiled anchor.
8. The system of claim 1, wherein the end portion of the docking device comprises tip with a loop, wherein the retrieval line is connected to the loop.
9. The system of claim 1, wherein the end portion of the docking device comprises tip with a groove, wherein the retrieval suture is coupled to the end portion in the groove.
10. The system of any one of claims 1-9, wherein the coiled docking device comprises:
 - at least one central turn having a first thickness and defining a central turn diameter;
 - an extension having a length extending from a proximal end of the at least one central turn, the extension having a second thickness that is less than the first thickness;
 - a proximal turn extending from a proximal end of the extension, the proximal turn having a third thickness that is greater than the second thickness.
11. The system of claim 10, wherein the coiled docking device comprises a distal turn on an opposite end of the coiled docking device from the end portion, the distal turn having the first thickness and defining a diameter that is greater than the central turn diameter.
12. The system of claim 10, wherein the end portion of the coiled docking device is at a proximal end of the proximal turn.
13. The system of claim 10, wherein the coiled docking device is configured to be implanted at the native valve with at least a portion of the coiled docking device positioned in a chamber of the heart and around valve leaflets of the native valve.

14. The system of claim 13, wherein the coiled docking device is configured to be implanted at the native mitral valve with at least a portion of the coiled docking device positioned in the left ventricle and around mitral valve leaflets of the native mitral valve.
15. The system of claim 13, wherein the coiled docking device is configured to be implanted at the native tricuspid valve with at least a portion of the coiled docking device positioned in the left ventricle and around tricuspid valve leaflets of the native tricuspid valve.
16. The system of any one of claims 1-15, further comprising a cover layer comprising a biocompatible material, wherein the cover layer surrounds at least a portion of the coiled anchor.
17. The system of claim 16, wherein the cover layer is a low friction cover layer, having a distal end and a proximal end, surrounding the coiled docking device and extending along a length of the coiled docking device, past a distal tip of the coiled docking device, and past a proximal tip of the coiled docking device, the low friction cover layer tapering to a rounded tip at its distal end.
18. The system of claim 16, further comprising a friction enhancing element that comprises a second cover layer surrounding and extending along at least a portion of the cover layer, wherein the second cover layer provides a coefficient of friction of at least 1.
19. The system of claim 18, wherein the second cover layer is a braided material.
20. The system of any one of claims 1-19, wherein the coiled docking device comprises:
 - at least one central turn defining a central turn diameter;
 - a lower turn extending from the at least one central turn defining a diameter that is greater than the central turn diameter;

an upper turn connected to the at least one central turn, the upper turn being shaped to have a first diameter along a first axis and a second diameter along a second axis,

wherein the first axis diameter is greater than the central turn diameter, and the second axis diameter is greater than the central turn diameter and less than the lower turn diameter.

21. The system of any one of claims 1-20, wherein the coiled docking device comprises:

a hollow tube having a proximal end and a distal end;

a plurality of cuts through portions of the tube;

a wire having a length, a proximal end, and a distal end;

wherein the distal end of the wire is secured to a distal end of the hollow tube and the proximal end of the wire is secured to a proximal end of the hollow tube;

wherein the length of the wire extends through the hollow tube and applies a radially inward tension on the hollow tube.

22. The system of claim 21, wherein the cuts have a pattern and shape that incorporates both longitudinal and transverse cuts forming teeth and grooves in the hollow tube.

23. The system of any one of claims 1-22, wherein the coiled docking device includes a core, and a distal end of the core has a rectangular cross-section and a distal ring-shaped tip.

24. The system of any one of claims 1-22, wherein the coiled docking device includes a core, and at least one end of the core has a ball-shaped tip.

25. A docking device for docking a prosthetic valve at a native valve of a heart, the docking device comprising:

a coiled docking device having an end portion with a central axis;

wherein the end portion of the docking device is configured such that a retrieval suture connected to the end portion will be biased to cause a line of force applied by tension to the retrieval suture to be aligned with the central axis.

26. The device of claim 25, wherein the end portion is configured to align at least a lengthwise portion of the retrieval suture along the central axis.
27. The device of claim 25, wherein the retrieval suture extends through a central passage at a tip of the end portion of the docking device, and wherein the central passage is aligned with the central axis.
28. The device of claim 25, wherein the coiled docking device further comprises a spherical tip on the proximal end portion which receives the retrieval suture.
29. The device of claim 28, wherein the spherical tip comprises an annular groove in a transition portion of the spherical tip.
30. The device of claim 25, wherein the end portion of the docking device comprises tip with a groove, wherein the retrieval suture is coupled to the end portion having a portion of the retrieval suture tied in the groove.
31. The device of any one of claims 25-30, wherein the coiled docking device comprises:
 - at least one central turn having a first thickness and defining a central turn diameter;
 - an extension having a length extending from an upper end of the at least one central turn, the extension having a second thickness that is less than the first thickness;
 - an upper turn extending from an upper end of the transition portion, the upper turn having a third thickness that is greater than the second thickness;
 - and
32. The device of claim 31, wherein the coiled docking device comprises a distal turn on an opposite end of the coiled docking device from the end portion, the distal

turn having the first thickness and defining a diameter that is greater than the central turn diameter.

33. The device of claim 31, wherein the coiled docking device is configured to be implanted at the native valve with at least a portion of the coiled docking device positioned in a chamber of the heart and around valve leaflets of the native valve.

34. The device of claim 33, wherein the coiled docking device is configured to be implanted at the native mitral valve with at least a portion of the coiled docking device positioned in the left ventricle and around mitral valve leaflets of the native mitral valve.

35. The device of claim 33, wherein the coiled docking device is configured to be implanted at the native tricuspid valve with at least a portion of the coiled docking device positioned in the left ventricle and around tricuspid valve leaflets of the native tricuspid valve.

36. The device of any one of claims 25-35, further comprising a cover layer comprising a biocompatible material, wherein the cover layer surrounds at least a portion of the coiled anchor.

37. The device of claim 36, wherein the cover layer is a low friction cover layer, having a distal end and a proximal end, surrounding the coiled docking device and extending along a length of the coiled docking device, past a distal tip of the coiled docking device, and past a proximal tip of the coiled docking device, the low friction cover layer tapering to a rounded tip at its distal end.

38. The device of claim 36, further comprising a friction enhancing element that comprises a second cover layer surrounding and extending along at least a portion of the cover layer, wherein the second cover layer provides a coefficient of friction of at least 1.

39. The device of claim 38, wherein the second cover layer is a braided material.

40. The device of any one of claims 25-39, wherein the coiled docking device comprises:
- at least one central turn defining a central turn diameter;
 - a lower turn extending from the at least one central turn defining a diameter that is greater than the central turn diameter;
 - an upper turn connected to the at least one central turn, the upper turn being shaped to have a first diameter along a first axis and a second diameter along a second axis,
 - wherein the first axis diameter is greater than the central turn diameter, and the second axis diameter is greater than the central turn diameter and less than the lower turn diameter.
41. The device of any one of claim 25-40, wherein the coiled docking device comprises:
- a hollow tube having a proximal end and a distal end;
 - a plurality of cuts through portions of the tube;
 - a wire having a length, a proximal end, and a distal end;
 - wherein the distal end of the wire is secured to a distal end of the hollow tube and the proximal end of the wire is secured to a proximal end of the hollow tube;
 - wherein the length of the wire extends through the hollow tube and applies a radially inward tension on the hollow tube.
42. The device of claim 41, wherein the cuts have a pattern and shape that incorporates both longitudinal and transverse cuts forming teeth and grooves in the hollow tube.
43. The device of any one of claims 25-42, wherein the coiled docking device includes a core, and a distal end of the core has a rectangular cross-section and a distal ring-shaped tip.

44. The device of any one of claims 25-42, wherein the coiled docking device includes a core, and at least one end of the core has a ball-shaped tip.
45. A method of retrieving a coiled docking device, the method comprising the steps of:
- pulling a retrieval line to pull an end portion of an coiled docking device against a pusher device, wherein the end portion of the coiled docking device is configured to bias the retrieval line to align a tension force applied by said pulling with a central axis of the end portion of the coiled docking device;
 - drawing pusher device and the end portion of the coiled docking device into a delivery catheter.
46. The method of claim 45, wherein the pusher device abuts a spherical end of the docking device.
47. The method of claim 45, wherein the end portion aligns at least a portion of the line along the central axis.
48. The method of claim 45, wherein the line extends through a central passage at a tip of the end portion of the docking device, and wherein the central passage is aligned with the central axis.