

WHAT IS CLAIMED IS:

1. A method for implanting artificial chordae to improve coaptation, the method comprising:

inserting a first artificial chordae having a first distal anchor disposed at a distal end portion of the first artificial chordae through an apex region of a heart, through a ventricle of the heart, and to a proximal side of a posterior annulus of the mitral valve, the first distal anchor disposed in a delivery configuration;

puncturing the posterior annulus to define an opening in the posterior annulus, the first artificial chordae extending through the opening so that the first distal anchor is positioned on a distal side of the posterior annulus;

deploying the first distal anchor so that the first distal anchor is moved to a deployed configuration to secure the first artificial chordae to the posterior annulus; and

anchoring a proximal end portion of the first artificial chordae to the heart to apply a force on the posterior annulus, the force being directed anteriorly towards the anterior annulus and downward toward the ventricle.

2. The method of claim 1 further comprising implanting a second artificial chordae in the posterior annulus, the second artificial chordae having a second distal anchor at a distal end portion.

3. The method of claim 2, wherein the second distal anchor of the second artificial chordae is deployed less than about 7 mm from the first distal anchor on the posterior annulus.

4. The method of any of claims 2 and 3 further comprising implanting less than or equal to four artificial chordae, each artificial chordae having a distal anchor at a respective distal end portion.

5. The method of claim 4, wherein each of the distal anchors of the respective implanted artificial chordae are positioned at least about 3 mm and less than or equal to about 7 mm from a nearest distal anchor on the posterior annulus.

6. The method of any of claims 1-5, wherein the first artificial chordae is inserted at least about 1 cm lateral to the left coronary artery.

7. The method of claim 6, wherein the first artificial chordae is inserted at least about 2 cm basal from a true apex of the heart.

8. The method of any of claims 1–7 further comprising:

inserting a second artificial chordae having a second distal anchor disposed at a distal end portion of the second artificial chordae through the apex region of the heart, through the ventricle of the heart, and to a proximal side of a posterior leaflet of the mitral valve, the second distal anchor disposed in a delivery configuration;

puncturing the posterior leaflet to define an opening in the posterior leaflet, the second artificial chordae extending through the opening so that the second distal anchor is positioned on a distal side of the posterior leaflet;

deploying the second distal anchor so that it is moved to a deployed configuration to secure the second artificial chordae to the posterior leaflet; and

anchoring a proximal end portion of the second artificial chordae to the heart to apply a force on the posterior leaflet, the force being directed anteriorly towards the anterior leaflet and downward toward the ventricle.

9. The method of claim 8, wherein the proximal end portion of the second artificial chordae is anchored to the heart in a different location from the proximal end portion of the first artificial chordae.

10. The method of any of claims 8 and 9 further comprising applying a first tension to the first artificial chordae and a second tension different from the first tension to the second artificial chordae.

11. The method of claim 10, wherein the first tension is greater than the second tension.

12. The method of any of claims 8–11, wherein a first delivery device is used to implant the first artificial chordae and a second delivery device different from the first delivery device is used to implant the second artificial chordae.

13. A method comprising:

inserting a first artificial chordae through an apex region of a heart, through a ventricle of the heart, and to a proximal side of a posterior annulus of the mitral valve, the first artificial chordae having a first distal anchor disposed in a delivery configuration;

deploying the first distal anchor so that the first distal anchor is moved to a deployed configuration to secure the first artificial chordae to the posterior annulus;

anchoring a proximal end portion of the first artificial chordae wherein a first tension on the first artificial chordae is directed anteriorly towards the anterior annulus and downward toward the ventricle;

inserting a second artificial chordae through the apex region of the heart, through the ventricle of the heart, and to a proximal side of a posterior leaflet of the mitral valve, the second artificial chordae having a second distal anchor disposed in a delivery configuration;

deploying the second distal anchor so that the second distal anchor is moved to a deployed configuration to secure the second artificial chordae to the posterior leaflet; and

anchoring a proximal end portion of the second artificial chordae wherein a second tension on the second artificial chordae causes the posterior leaflet to move downward toward the ventricle to increase coaptation.

14. The method of claim 13, wherein the first tension is greater than the second tension.

15. The method of any of claims 13 and 14 further comprising adjusting the first tension after anchoring of the second artificial chordae.

16. The method of claim 15 further comprising adjusting the second tension independent of adjustments to the first tension.

17. The method of any of claims 13–16, wherein the second tension is configured to cause the surface of coaptation to be at least about 4 mm.

18. The method of any of claims 13–17, wherein the combination of the first tension and the second tension decreases a distance between the anterior annulus and the posterior annulus by at least about 10%.

19. The method of any of claims 13–18, wherein the first artificial chordae is anchored to the heart in a different location from the second artificial chordae.

20. The method of any of claims 13–19, wherein the second tension is configured to cause the second distal anchor to be below the anterior leaflet during coaptation.

21. An apparatus comprising:

a pusher having a distal end;

a needle having a distal portion, the needle slidably disposed within the pusher with the distal portion of the needle extending from the distal end of the pusher; and

a suture having a first section and a second section, each of the first section and the second section having a first portion and a second portion, the second portion of each section including a coil that has a proximal end and a distal end and being formed of multiple turns about an exterior of the needle,

a first end of the second portion of the first section being at the distal end of the coil of the first section;

a first end of the second portion of the second section coupled to the first end of the second portion of the first section;

the first section forming a first loop forming segment having a first end at the proximal end of the first coil, a second end at the distal end of the first coil, and being routed proximally external to the second coil and distally internal to the second coil;

the second section forming a second loop forming segment having a first end at the distal end of the second coil, a second end at the proximal end of the first coil, and being routed distally external to the first coil and proximally internal to the first coil;

the second section forming a first loop by routing the first portion of the second section proximally along the exterior of the coil of the second section and distally through the proximal end of the coil of the second section, internal to the coil of the second section, and out a portion of the coil of the second section between the distal end and the proximal end of the coil of the second section;

the first section forming a second loop by routing the first portion of the first section distally along the exterior of the coil of the second section and proximally through the distal end of the coil of the first section, internal to the coil of the first section, and out a portion of the coil of the first section between the distal end and the proximal end of the coil of the first section;

the first portion of the first section is crossed with the first portion of the second section and routed through the first loop; and

the first portion of the second section is crossed with the first portion of the first section and routed through the second loop.

22. The apparatus of claim 21, wherein the suture is configured for the coil of the first section and the coil of the second section to be formed into a flattened loop by withdrawing the needle proximally through the coil of the first section and the coil of the second section such that the pusher separates the coil of the first section and the coil of the second section from the needle.

23. The apparatus of claim 22, wherein the apparatus is further configured to form the flattened loop by withdrawing the first portion of the second section relative to the distal end of the pusher to draw the second end of the second loop forming segment proximally from the proximal end of the coil of the first section to deflect the distal end of the coil of the first section laterally with respect to the proximal end of the coil of the first section and to draw the proximal end and the distal end of the coil of the first section towards each other to form a portion of the flattened loop.

24. The apparatus of claim 23, wherein the apparatus is further configured to form the flattened loop by withdrawing the first portion of the first section relative to the distal end of the pusher to draw the second end of the first loop forming segment proximally from the proximal end of the coil of the second section to deflect the distal end of the coil of the second section laterally with respect to the proximal end of the coil of the second section and to draw the proximal end and the distal end of the coil of the second section towards each other to form a portion of the flattened loop.

25. The apparatus of any of claims 21–24, wherein the needle defines an interior lumen and a distal portion of the needle includes a slot in communication with the lumen.

26. A method for manufacturing a suture with a distal anchor, the method comprising:

- forming a first coil on a distal portion of the needle, the first coil being formed of multiple turns of a second portion of a first section of the suture about an exterior of the needle, the first coil having a proximal end and a distal end;
- forming a second coil on a proximal portion of the needle, the second coil being formed of multiple turns of a second portion of a second section the suture about an exterior of the needle, the second coil having a proximal end and a distal end;
- forming a first loop forming segment of the second portion of the first section by routing proximally the second portion of the first section from the proximal end of the first coil, external to the first coil and the second coil, towards the

proximal end of the second coil and extending distally through the interior of the second coil to the distal end of the second coil;

forming a second loop forming segment of the second portion of the second section by routing distally the second portion of the second section from the distal end of the second coil, external to the first coil and the second coil, towards the distal end of the first coil and extending proximally through the interior of the first coil to the proximal end of the first coil;

forming a first loop by routing a first portion of the second section proximally along the exterior of the second coil and then distally and internally through the proximal end of the second coil and out a portion of the second coil between the distal end and the proximal end of the second coil;

forming a second loop by routing a first portion of the first section distally along the exterior of the first coil and then proximally and internally through the distal end of the first coil and out a portion of the first coil between the distal end and the proximal end of the first coil;

crossing the first portion of the first section with the first portion of the second section;

routing the first portion of the first section through the first loop;

crossing the first portion of the second section with the first portion of the first section; and

routing the first portion of the second section through the second loop.

27. The method of claim 26 further comprising shortening the first loop forming segment and the second loop forming segment by pulling the first portion of the first section and the first portion of the second section.

28. The method of any of claims 26–27 further comprising shortening the first loop and the second loop by pulling the first portion of the first section and the first portion of the second section.

29. The method of any of claims 26–28, wherein forming the first coil and the second coil comprises rotating the needle such that the second portion of the first section and the second portion of the second section form multiple turns about the exterior of the needle.

30. The method of any of claims 26–29 further comprising disposing knot rings about the suture and the needle to secure the suture to the needle.

31. The method of claim 30 further comprising removing the knot rings after forming the first loop forming segment and the second loop forming segment.

32. The method of any of claims 26–31, wherein the needle defines an interior lumen and a distal portion of the needle includes a slot in communication with the lumen.

33. The method of claim 32 further comprising routing proximally the first portion of the first section and the first portion of the second section into a distal end of the interior lumen of the needle.

34. The method of any of claims 32–33, wherein routing the second portion of the first section through the interior of the second coil includes routing the second portion of the first section within the slot of the needle.

35. The method of any of claims 32–34, wherein routing the second portion of the second section through the interior of the first coil includes routing the second portion of the second section within the slot of the needle.

36. The method of any of claims 32–35, wherein routing the first portion of the first section through the first loop includes routing the first portion of the first section into the slot of the needle.

37. The method of any of claims 32–36, wherein routing the first portion of the second section through the second loop includes routing the first portion of the second section into the slot of the needle.