

Summary

[1013] Apparatus and methods for performing a non-invasive procedure to repair a cardiac valve are described herein. In some embodiments, devices to deliver a distal anchor within the atrium of the heart are described herein. Such a device can include a handle, an actuator operably coupled to the handle, a pusher device, a puncture member coupled to the actuator and at least partially disposed within a lumen defined by the pusher device, and a distal anchor. The distal anchor is disposed at a distal end portion of an artificial chordae and disposed in a delivery configuration. The artificial chordae has a proximal end portion coupled to the handle. The proximal end portion of the artificial chordae extends through a lumen defined by the puncture member. The actuator can be actuated to move the puncture member distally a preset distance, and to move the pusher device distally such that at least a portion of the distal anchor is moved distal to the distal end of the puncture member and the distal anchor is moved from its delivery configuration to a deployed configuration.

[1013a] In another embodiment, an apparatus comprises a handle, an actuator operably coupled to the handle, a pusher device defining a lumen, a puncture member coupled to the actuator and at least partially disposed within the lumen of the pusher device, and a distal anchor disposed at a distal end portion of an artificial chordae and disposed in a delivery configuration. The artificial chordae has a proximal end portion coupled to the handle and extending through a lumen defined by the puncture member, the actuator is configured to be actuated at a first time period such that (1) the puncture member is moved distally a preset distance, and (2) the pusher device is moved distally such that at least a portion of the distal anchor is moved distally relative to the puncture member and disposed distal to the distal end of the puncture member. The actuator is configured to be actuated at a second time period after the first time period such the distal anchor is moved from the delivery configuration to a deployed configuration.

Brief Description of the Drawings

[1014] FIG. 1 is a cut-away anterior view of a heart, showing the internal chambers, valves and adjacent structures.

[1015] FIG. 2A is a top perspective view of a healthy mitral valve with the mitral leaflets closed.

[1016] FIG. 2B is a top perspective view of a dysfunctional mitral valve with a visible gap between the mitral leaflets.

[1017] FIG. 2C is a cross-sectional view of a heart illustrating a mitral valve prolapsed into the left atrium.

[1018] FIG. 2D is an enlarged view of the prolapsed mitral valve of Fig. 2C.

[1019] FIG. 3 is a cross-sectional view of a heart showing the left atrium, right atrium, left ventricle, right ventricle and the apex region.

[1020] FIG. 4 is a schematic illustration of a delivery device, according to an embodiment, shown inserted into a portion of a heart.

Claims

1. An apparatus, comprising:
 - a handle;
 - an actuator operably coupled to the handle;
 - a pusher device defining a lumen;
 - a puncture member coupled to the actuator and at least partially disposed within the lumen of the pusher device; and
 - a distal anchor disposed at a distal end portion of an artificial chordae, the distal anchor disposed in a delivery configuration,
 - the artificial chordae having a proximal end portion coupled to the handle and extending through a lumen of the puncture member,
 - the actuator configured to be actuated such that (1) the puncture member is moved distally a preset distance, and (2) the pusher device is moved distally such that the distal anchor is (a) moved distal to the distal end of the puncture member, and (b) moved from the delivery configuration to a deployed configuration.
2. The apparatus of claim 1, wherein:
 - the actuator is configured to be actuated such that the pusher device is moved distally beyond the distal end of the puncture member, the proximal end portion of the artificial chordae being fixedly coupled to at least one of the actuator or the handle as the pusher device is moved distally beyond the distal end of the puncture member.
3. The apparatus of claim 1, further comprising:
 - an outer tube coupled to the handle,
 - the pusher device being movably disposed within a lumen of the outer tube,
 - the distal anchor being disposed in the delivery configuration within a distal end portion of the lumen of the outer tube.
4. The apparatus of claim 3, further comprising:
 - an end effector disposed at a distal end portion of the outer tube, the end effector having a diameter greater than a diameter of the distal end portion of the outer tube.

5. The apparatus of claim 1, wherein:
in the delivery configuration, the distal anchor has a first diameter,
in the deployed configuration, the distal anchor has a second diameter greater than the first diameter.
6. The apparatus of claim 1, wherein:
in the delivery configuration, the distal anchor has a first width,
in the deployed configuration, the distal anchor has a second width greater than the first width.
7. The apparatus of claim 1, wherein:
the distal end portion of the artificial chordae defines the distal anchor, the distal anchor being disposed in an elongated coiled configuration when in the delivery configuration,
when the actuator is actuated at the second time period, the proximal end portion of the artificial chordae is pulled proximally and the distal anchor is moved from the elongated coiled configuration to the deployed configuration, the distal anchor being disposed in a coiled knot configuration when in the deployed configuration.
8. The apparatus of claim 7, wherein the actuator is a plunger, the plunger being movably coupled to the handle, the puncture member being releasably coupled to the plunger.
9. The apparatus of claim 1, wherein the preset distance is about 0.2 inches to about 0.3 inches.
10. The apparatus of claim 1, wherein the preset distance is a first preset distance, the actuator is configured to be actuated such that the pusher device is moved distally a second preset distance and beyond the distal end of the puncture member, the first preset distance being about 0.2 inches to about 0.3 inches, the second preset distance being about 0.6 inches to about 0.7 inches.

11. The apparatus of claim 1, further comprising:

a lock configured to prevent actuation of the actuator when the lock is engaged, the lock configured to allow actuation of the actuator when the lock is disengaged.

12. An apparatus, comprising:

a handle;

an actuator operably coupled to the handle;

a pusher device defining a lumen;

a puncture member coupled to the actuator and at least partially disposed within the lumen of the pusher device; and

a distal anchor disposed at a distal end portion of an artificial chordae and disposed in a delivery configuration,

the artificial chordae having a proximal end portion coupled to the handle and extending through a lumen defined by the puncture member,

the actuator configured to be actuated at a first time period such that (1) the puncture member is moved distally a preset distance, and (2) the pusher device is moved distally such that at least a portion of the distal anchor is moved distally relative to the puncture member and disposed distal to the distal end of the puncture member,

the actuator configured to be actuated at a second time period after the first time period such the distal anchor is moved from the delivery configuration to a deployed configuration.

13. The apparatus of claim 12, further comprising:

an outer tube coupled to the handle, the pusher device being movably disposed within a lumen of the outer tube, the distal anchor disposed in the delivery configuration within a distal end portion of the lumen of the outer tube; and

an end effector disposed at the distal end portion of the outer tube, the end effector having a diameter greater than a diameter of the distal end portion of the outer tube.

14. The apparatus of claim 12, wherein:
in the delivery configuration, the distal anchor has a first diameter,
in the deployed configuration, the distal anchor has a second diameter greater than the first diameter.
15. The apparatus of claim 12, wherein:
in the delivery configuration, the distal anchor has a first width,
in the deployed configuration, the distal anchor has a second width greater than the first width.
16. The apparatus of claim 12, wherein the artificial chordae is a suture.
17. The apparatus of claim 12, wherein:
the distal end portion of the artificial chordae defines the distal anchor, the distal anchor being disposed in an elongated coiled configuration when in the delivery configuration,
when the actuator is actuated at the second time period, the proximal end portion of the artificial chordae is pulled proximally and the distal anchor is moved from the elongated coiled configuration to the deployed configuration, the distal anchor being disposed in a coiled knot configuration when in the deployed configuration.
18. The apparatus of claim 17, wherein the actuator is a plunger, the plunger being movably coupled to the handle, the puncture member being coupled to the plunger.
19. The apparatus of claim 12, wherein the preset distance is about 0.2 inches to about 0.3 inches.
20. The apparatus of claim 12, further comprising:
a lock configured to prevent actuation of the actuator when the lock is engaged, the lock configured to allow actuation of the actuator when the lock is disengaged.

21. The apparatus of claim 12, further comprising:
an outer tube coupled to the handle,
when the actuator is actuated at the first time period, both the pusher device and the
puncture member are moved proximally through a lumen of the outer tube.