detected at the time of the procedure. However, due to inability to reposition or retrieve the device, these problems were impossible to reverse or mitigate during the procedure.

SUMMARY

[0005a] According to an aspect of the present invention, there is provided a biocompatible articulated support structure for a prosthetic valve, comprising a tubular support body with a proximal opening, a distal opening, and a lumen and a longitudinal axis between the proximal and distal openings; wherein the tubular support body comprises a plurality of discrete struts coupled by a plurality of rotatable articulations, each rotatable articulation comprising an axis of rotation with a radial orientation; wherein the plurality of rotatable articulations comprise: a set of proximal rotatable articulations configured to reside in a proximal plane with the proximal opening; a set of distal rotatable articulations configured to reside in a distal plane with the distal opening; and a first set of middle rotatable articulations, located between the proximal plane and the distal plane; characterized in that: the support structure further comprises at least one commissural point articulation distal to the distal plane; the plurality of discrete struts and the articulations therebetween intrinsically provide a self-expansion force; and the plurality of discrete struts comprises a plurality of inner struts, a plurality of outer struts, at least one inner commissural strut, and at least one outer commissural strut.

[0005b] Disclosed herein is a biocompatible articulated support structure, including: a tubular structure including: a central lumen; a central axis; a plurality of discrete inner struts; and a plurality of discrete outer struts; wherein each of the plurality of discrete inner struts and the plurality of discrete outer struts comprises first end, a second end, and a net length therebetween; wherein each of the plurality of discrete inner struts comprises articulations with at least two different discrete outer struts of the plurality of discrete outer struts; wherein each of the plurality of discrete outer struts comprises articulations with at least two different discrete inner struts of the plurality of discrete inner struts; wherein no discrete inner strut of the plurality of discrete inner struts comprises articulations with any other discrete inner strut of the plurality of discrete inner struts; wherein no discrete outer strut of the plurality of discrete outer struts comprises articulations with any other discrete outer strut of the plurality of discrete outer struts; and wherein at least one strut from either the plurality of discrete inner struts or the plurality of discrete outer struts comprises first end, a second end, and a net length therebetween, and wherein the first end of the at least one strut is spaced apart from a closest articulation by about at least 25% of the net length of that strut.

[0005c] Disclosed herein is a biocompatible articulated structure, including: a tubular structure including: a central lumen; a central axis; a plurality of discrete inner struts; a plurality of discrete outer struts; and at least two radial struts; wherein each of the plurality of discrete inner struts and the plurality of discrete outer struts comprises first end, a second end, and a net length therebetween; wherein each of the at least two radial struts comprises an outer end, an inner end and a net length therebetween, wherein each outer end is coupled to at least one strut selected from the plurality of discrete inner struts and the plurality of discrete outer struts, and wherein the inner ends of the at least two radial struts are coupled together; wherein each of the plurality of discrete inner struts comprises articulations with at least three different discrete outer struts of the plurality of discrete outer struts; wherein each of the plurality of discrete outer struts comprises articulations with at least three different discrete inner struts of the plurality of discrete inner struts; wherein no discrete inner strut of the plurality of discrete inner struts comprises articulations with any other discrete inner strut of the plurality of discrete inner struts; and wherein no discrete outer strut of the plurality of discrete outer struts comprises articulations with any other discrete outer strut of the plurality of discrete outer struts.

[0005d] Disclosed herein is a biocompatible articulated structure, including: a tubular structure including: a central lumen; a central axis; plurality of discrete inner struts; and a plurality of discrete outer struts; wherein each of the plurality of discrete inner struts and the plurality of discrete outer struts comprises first end, a second end, and a net length therebetween; wherein each of the plurality of discrete inner struts comprises articulations with at least four different discrete outer struts of the plurality of discrete outer struts; wherein each of the plurality of discrete outer struts comprises articulations with at least four different discrete inner struts of the plurality of discrete inner struts; wherein no discrete inner strut of the plurality of discrete inner struts comprises articulations with any other discrete inner strut of the plurality of discrete inner struts; wherein no discrete outer strut of the plurality of discrete outer struts comprises articulations with any other discrete outer strut of the plurality of discrete outer struts; wherein at least one strut from either the plurality of discrete inner struts or the plurality of discrete outer struts comprises first end, a second end, and a net length therebetween; and wherein the plurality of discrete inner struts, the plurality of discrete outer struts and the articulations therebetween intrinsically provide a self-expansion force.

[0005e] Disclosed herein is a biocompatible articulated support structure, including: a tubular structure including: a central lumen; a central axis; a plurality of discrete inner struts; a plurality of discrete outer struts;

and a plurality of discrete commissure struts; wherein each of the plurality of discrete inner struts and the plurality of discrete outer struts comprises a first end, a second end, and a net length therebetween; wherein each of the plurality of discrete inner struts comprises articulations with at least three different discrete outer or commissure struts of the pluralities of discrete outer and commissure struts; wherein each of the plurality of discrete outer struts comprises articulations with at least three different discrete inner or commissure struts of the pluralities of discrete inner and commissure struts; wherein each of the plurality of discrete commissure struts comprises articulations with one discrete outer or inner strut of the pluralities of discrete outer and inner struts and with one other discrete commissure strut of the plurality of discrete commissure struts; wherein no discrete inner strut of the plurality of inner struts comprises articulations with any other discrete inner strut of the plurality of discrete inner struts; and wherein no discrete outer strut of the plurality of discrete outer struts comprises articulations with any other discrete outer strut of the plurality of discrete outer struts.

[0005f] Disclosed herein is a biocompatible articulated support structure, including: an hourglass structure including: a central lumen; a central axis; a plurality of discrete inner struts; and a plurality of discrete outer struts; wherein each of the plurality of discrete inner struts and the plurality of discrete outer struts comprises a first end, a second end, and a net length therebetween; wherein each of the plurality of discrete inner struts and the plurality of discrete outer struts has a helical configuration with the helical axis aligned with the central axis of the structure; wherein each of the plurality of discrete inner struts comprises two articulations with a single discrete outer strut of the plurality of discrete outer struts, and at least one articulation with a different discrete outer strut of the plurality of discrete outer struts; wherein each of the plurality of discrete outer struts comprises two articulations with a single discrete inner strut of the plurality of discrete inner struts, and at least one articulation with a different discrete inner strut of the plurality of discrete inner struts; wherein no discrete inner strut of the plurality of inner struts comprises articulations with any other discrete inner strut of the plurality of discrete inner struts; wherein no discrete outer strut of the plurality of discrete outer struts comprises articulations with any other discrete outer strut of the plurality of discrete outer struts; and wherein the diameter of the support structure at either end of the central axis is greater than the diameter of the support structure at the midpoint of the central axis.

[0005g] Disclosed herein is a biocompatible articulated support structure, including: a tubular structure including: a central lumen; a

central axis; a plurality of discrete inner struts; and a plurality of discrete outer struts; wherein each of the plurality of discrete inner struts and the plurality of discrete outer struts comprises a first end, a second end, and a net length therebetween; wherein each of the plurality of discrete inner struts comprises articulations with at least three different discrete outer struts of the plurality of discrete outer struts; wherein each of the plurality of discrete outer struts comprises articulations with at least three different discrete inner struts of the plurality of discrete inner struts; wherein no discrete inner strut of the plurality of inner struts comprises articulations with any other discrete inner strut of the plurality of discrete inner struts; wherein no discrete outer strut of the plurality of discrete outer struts comprises articulations with any other discrete outer strut of the plurality of discrete outer struts; and wherein the support structure is in an unstressed state when in a fully expanded configuration.

[0005h] Disclosed herein is a biocompatible articulated support structure, including: a valve structure, including: a tubular structure including: a central lumen; a central axis; a plurality of discrete inner struts; a plurality of discrete outer struts; and a plurality of discrete commissure struts; wherein each of the plurality of discrete inner struts and the plurality of discrete outer struts comprises a first end, a second end, and a net length therebetween; wherein each of the plurality of discrete inner struts comprises articulations with at least three different discrete outer or commissure struts of the pluralities of discrete outer and commissure struts; wherein each of the plurality of discrete outer struts comprises articulations with at least three different discrete inner or commissure struts of the pluralities of discrete inner and commissure struts; wherein each of the plurality of discrete commissure struts comprises articulations with one discrete outer or inner strut of the pluralities of discrete outer and inner struts and with one other discrete commissure strut of the plurality of discrete commissure struts; wherein no discrete inner strut of the plurality of inner struts comprises articulations with any other discrete inner strut of the plurality of discrete inner struts; and wherein no discrete outer strut of the plurality of discrete outer struts comprises articulations with any other discrete outer strut of the plurality of discrete outer struts; a fixation structure, including: an hourglass structure including: a central lumen; a central axis; a plurality of discrete inner struts; and a plurality of discrete outer struts; wherein each of the plurality of discrete inner struts and the plurality of discrete outer struts comprises a first end, a second end, and a net length therebetween; wherein each of the plurality of discrete inner struts and the plurality of discrete outer struts has a helical configuration with the helical axis aligned with the central axis of the structure; wherein each of the plurality of discrete inner struts comprises two

articulations with a single discrete outer strut of the plurality of discrete outer struts, and at least one articulation with a different discrete outer strut of the plurality of discrete outer struts; wherein each of the plurality of discrete outer struts comprises two articulations with a single discrete inner strut of the plurality of discrete inner struts, and at least one articulation with a different discrete inner strut of the plurality of discrete inner struts; wherein no discrete inner strut of the plurality of inner struts comprises articulations with any other discrete inner strut of the plurality of discrete inner struts; wherein no discrete outer strut of the plurality of discrete outer struts comprises articulations with any other discrete outer strut of the plurality of discrete outer struts; and wherein the diameter of the support structure at either end of the central axis is greater than the diameter of the support structure at the midpoint of the central axis; at least two locking ring structures, including: a tubular structure including: a central lumen; a central axis; a plurality of discrete inner struts; and a plurality of discrete outer struts; wherein each of the plurality of discrete inner struts and the plurality of discrete outer struts comprises a first end, a second end, and a net length therebetween; wherein each of the plurality of discrete inner struts comprises articulations with at least three different discrete outer struts of the plurality of discrete outer struts; wherein each of the plurality of discrete outer struts comprises articulations with at least three different discrete inner struts of the plurality of discrete inner struts; wherein no discrete inner strut of the plurality of inner struts comprises articulations with any other discrete inner strut of the plurality of discrete inner struts; wherein no discrete outer strut of the plurality of discrete outer struts comprises articulations with any other discrete outer strut of the plurality of discrete outer struts; and wherein the support structure is in an unstressed state when in a fully expanded configuration; wherein the central axes of the valve structure, fixation structure, and two locking ring structures are aligned; wherein the valve structure is attached to least one point of the fixation structure; and wherein each of the two locking ring structures is attached to least one point of the fixation structure.

[0005i] Disclosed herein is a biocompatible support structure delivery system, including: an expandable support structure having proximal and distal ends; at least one ring attached to the proximal end of the support structure; at least one ring attached to the distal end of the support structure; wherein the at least one rings are attached to the support structure by loops, such that the rings can rotate freely within the loops; and wherein the rings are configured to attach to a control catheter assembly.

[0006] An endoluminal support structure or stent in accordance with certain embodiments of the invention solves certain deficiencies found in the prior art. In particular, the support structure can be repositioned within the body lumen or retrieved from the lumen.

[0007] A particular embodiment of the invention includes a support apparatus implantable within a biological lumen. The support apparatus can include a plurality of elongated strut members interlinked by a plurality of rotatable joints, wherein the rotatable joints can cooperate with the stent members to adjustably define a shaped structure between a compressed orientation and an expanded orientation.

[0008] More particularly, the shaped structure can be one of a cylindrical, a conical, or an hourglass shape. A rotatable joint can form a scissor mechanism with a first strut member and a second strut member. Furthermore, the strut members can be arranged as a series of linked scissor mechanisms. The apparatus can further include an actuation mechanism to urge the rotatable joints within a range of motion.

[0009] The apparatus can also include a prosthetic valve coupled to the shaped structure.

[0010] Another particular embodiment of the invention can include a medical stent implantable within a biological lumen. The medical stent can include a plurality of elongated strut members, including a first strut member and a second strut member, and a rotatable joint connecting the first strut member and the second strut member.

[0011] In particular, the rotatable joint can form a scissor mechanism with the first strut member and the second strut member. The rotatable joint can bisect the first strut member and the second strut member. The rotatable joint can interconnect a first end of the first strut member with a first end of the second strut member.

[0012] The plurality of strut members can be arranged as a series of linked scissor mechanisms. The strut members can also be non-linear. The strut members can be arranged to form one of a cylindrical, a conical, or an hourglass shape.

CLAIMS

1. A biocompatible articulated support structure for a prosthetic valve, comprising a tubular support body with a proximal opening, a distal opening, and a lumen and a longitudinal axis between the proximal and distal openings;

wherein the tubular support body comprises a plurality of discrete struts coupled by a plurality of rotatable articulations, each rotatable articulation comprising an axis of rotation with a radial orientation;

wherein the plurality of rotatable articulations comprise:

a set of proximal rotatable articulations configured to reside in a proximal plane with the proximal opening;

a set of distal rotatable articulations configured to reside in a distal plane with the distal opening; and

a first set of middle rotatable articulations, located between the proximal plane and the distal plane;

characterized in that:

the support structure further comprises at least one commissural point articulation distal to the distal plane;

the plurality of discrete struts and the articulations therebetween intrinsically provide a self-expansion force; and

the plurality of discrete struts comprises a plurality of inner struts, a plurality of outer struts, at least one inner commissural strut, and at least one outer commissural strut.

2. The biocompatible articulated support structure of claim 1, wherein each of the at least one commissural point articulations is linked by at least two of the plurality of discrete struts to two commissural base articulations.

3. The biocompatible articulated support structure of claim 2, wherein the two commissural base articulations are located at or proximal to the distal plane.

4. The biocompatible articulated support structure of claim 1, wherein the first set of middle rotatable articulations, when the tubular support body is in an expanded state, are located closer to the proximal plane than the distal plane.

5. The biocompatible articulated support structure of claim 1, wherein each of the plurality of inner struts is coupled to two of the plurality of outer struts, and a third discrete strut from either the plurality of outer struts or the at least one outer commissural strut.

6. The biocompatible articulated support structure of claim 1 or claim 5, wherein each of the plurality of outer struts is coupled to two of the plurality of inner struts, and a third discrete strut from either the plurality of inner struts or the at least one inner commissural strut.

7. The biocompatible articulated support structure of claim 1, wherein each of the plurality of inner struts is coupled to two of the plurality of outer struts, and is also coupled to either another of the plurality of outer struts or the at least one outer commissural strut but not to both.

8. The biocompatible articulated support structure of claim 1 or claim 7, wherein each of the plurality of outer struts is coupled to two of the plurality of inner struts, and is also coupled to either another of the plurality of inner struts or the at least one inner commissural strut but not to both.

9. The biocompatible articulated support structure of claim 1, wherein when the tubular support body is in an expanded state, the average angle of the at least one commissural point articulation is less than the average angle of the set of distal rotatable articulations.

10. The biocompatible articulated support structure of claim 6 or claim 8, wherein each of the plurality of inner struts that is not coupled to a commissural strut and each of the plurality of outer struts that is not coupled to a commissural strut has a first length, and wherein each of the plurality of inner struts that is coupled to a commissural strut and each of the plurality of outer struts coupled to a commissural strut has a second length.

11. The biocompatible articulated support structure of claim 10, wherein the second length is different from the first length.

12. The biocompatible articulated support structure of claim 11, wherein the second length is shorter than the first length.

13. The biocompatible articulated support structure of claim 1, wherein when the tubular support body is in the expanded state, a distance between the at least one commissural point articulation and the distal plane is at least 20% of a longitudinal distance between the proximal and distal planes.

14. The biocompatible articulated support structure of claim 1, further comprising an expandable hourglass securing body comprising a proximal opening, and a distal opening, with a lumen and a longitudinal axis between the proximal and distal openings, and wherein the tubular support body is configured to reside within the lumen of the expandable hourglass securing body.

15. The biocompatible articulated support structure of claim 14, wherein the expandable hourglass securing body comprises a distal tapered section, a proximal tapered section, and a narrow section therebetween, and wherein the tubular support body is secured to the narrow section; and

optionally further comprising at least one locking ring secured to at least one of the distal tapered section and the proximal tapered section;

further optionally wherein either:

the at least one locking ring is located within the lumen of the expandable hourglass securing body; or

the at least one locking ring comprises a plurality of inner struts and a plurality of outer struts interconnected by rotatable articulations, each rotatable articulation comprising with an axis of rotation with a radial orientation.

16. The biocompatible articulated support structure of claim 15, wherein the expandable hourglass securing body comprises a plurality of discrete non-linear struts interconnected by rotatable articulations, each rotatable articulation comprising an axis of rotation with a radial orientation.