damaging the baroreceptor structure and function thereof can decrease the pulmonary artery pressure, which can provide more successful treatments of pulmonary hypertension.

[0004a] In one aspect, there is provided a device for ablating a target tissue of a patient, the device comprising:

a catheter body comprising a proximal end and a terminal distal end;

an elliptical ring coupled to the terminal distal end of the catheter body, the elliptical ring having a major axis and a minor axis, wherein the minor axis divides the elliptical ring into a first portion and a second portion, the first portion encompassing an apex of the major axis; and

a plurality of electrodes supported by the elliptical ring,

wherein a number of electrodes supported by the first portion of the elliptical ring exceeds a number of electrodes supported by the second portion of the elliptical ring.

[0005] Some embodiments disclosed herein provide a multi-pole synchronous pulmonary artery radiofrequency ablation catheter for treatment of pulmonary hypertension in the pulmonary artery by a de-sympathetic method. In some embodiments, the catheter only heats the adherent tissue rather than the blood. Additionally, in some embodiments, the catheter can be configured to provide cold saline perfusion at or near the ablation site to protect the vascular intima. Some embodiments can also provide advantages of simple operation, short operation time and controllable, precise ablation.

[0006] In some embodiments, a multi-pole synchronous pulmonary artery radiofrequency ablation catheter can comprise a control handle, a catheter body and an annular ring. The control handle can be provided with an adjustment apparatus. The catheter body can be hollow and can include a cavity. One or a plurality of lead wires, one or more temperature sensing wires and one or more pull wires can be arranged in the cavity. One end of the catheter body can be flexible. The flexible end can be connected to an annular ring and the other end of the catheter body can be connected to the control handle. One end of the pull wire can be connected to the flexible end and the other end of the pull wire can be connected to the adjustment apparatus. Tension in the pull wire can be adjusted through the adjustment apparatus to achieve shape control, such as curvature control, of the flexible end. A shape memory wire can be arranged in the annular ring. One end of the shape memory wire can

extend to the end of the annular ring and the other end of the shape memory wire can pass through the root of the annular ring and can be fixed on the flexible end of the catheter body. The annular ring can be provided with an electrode group with each electrode connected to the one or more lead wires and the one or more temperature sensing wires. The lead wire(s) and the temperature sensing wire(s) extend through the catheter body and are electrically connected to the control handle.

[0007] An infusion tube can be arranged in the cavity of the catheter body and a through hole can be arranged on one or more of the electrodes. The infusion tube can be connected to the electrodes through the annular ring. The transfused fluid flows out from the

WHAT IS CLAIMED IS:

1. A multi-pole synchronous pulmonary artery radiofrequency ablation catheter, comprising:

a control handle including an adjustment apparatus;

a catheter body being hollow and comprising a cavity arranged in the catheter body; and

an annular ring,

wherein a lead wire, a temperature sensing wire and a pull wire are arranged in the cavity;

wherein one end of the catheter body is flexible, and the flexible end is connected to the annular ring, and wherein the other end of the catheter body is connected to the control handle;

wherein one end of the pull wire is connected to the flexible end, and the other end of the pull wire is connected to the adjustment apparatus on the control handle, the adjustment apparatus adjusts the tension of the pull wire to change a curvature of the flexible end;

wherein a shape memory wire is arranged in the annular ring, and one end of the shape memory wire extends to an end of the annular ring and the other end of the shape memory wire passes through a root of the annular ring and is fixed on the flexible end of the catheter body;

wherein the annular ring is provided with an electrode group comprising a first electrode of a first length, a second electrode of a second length different than the first length, and a third electrode, each electrode of the electrode group connected to the lead wire and temperature sensing wire;

wherein the lead wire and the temperature sensing wire go through the catheter body and are electrically connected to the control handle.

2. The multi-pole synchronous pulmonary artery radiofrequency ablation catheter according to Claim 1, wherein the electrodes of the electrode group are substantially coplanar.

3. The multi-pole synchronous pulmonary artery radiofrequency ablation catheter according to Claim 1, wherein the annular ring, extending from the root of the annular ring to the end of the annular ring, comprises a curve of less than 360 degrees.

4. The multi-pole synchronous pulmonary artery radiofrequency ablation catheter according to Claim 3, wherein the annular ring, extending from the root of the annular ring to the end of the annular ring, comprises a curve of more than 270 degrees.

5. The multi-pole synchronous pulmonary artery radiofrequency ablation catheter according to Claim 3, wherein the annular ring comprises a first diameter and a second diameter different than the first diameter.

6. The multi-pole synchronous pulmonary artery radiofrequency ablation catheter according to Claim 5, wherein the first diameter is at least 25 mm and the second diameter is at least 20 mm.

7. The multi-pole synchronous pulmonary artery radiofrequency ablation catheter according to Claim 1, wherein the first length is least 4 mm.

8. The multi-pole synchronous pulmonary artery radiofrequency ablation catheter according to Claim 1, wherein the second length is least 3 mm.

9. The multi-pole synchronous pulmonary artery radiofrequency ablation catheter according to Claim 1, wherein the third electrode comprises a third length different than the first length and different than the second length.

10. The multi-pole synchronous pulmonary artery radiofrequency ablation catheter according to Claim 1, wherein the third length is at least 2 mm.

11. A catheter, comprising:

a catheter body; and

an annular ring, wherein one end of the catheter body is flexible and connected to the annular ring,

wherein the annular ring is provided with an electrode group comprising a first electrode of a first length, a second electrode of a second length different than the first length, and a third electrode of a third length different than the first length and different than the second length.

12. The catheter according to Claim 11, wherein the electrodes of the electrode group are substantially coplanar and arranged along a curve of the annular ring that extends from a root of the annular ring to an end of the annular ring.

13. The catheter according to Claim 12, wherein the curve of the annular ring is less than 360 degrees and greater than 270 degrees.

14. The catheter according to Claim 11, wherein the first length is least 4 mm.

15. The catheter according to Claim 14, wherein the second length is least 3 mm and is less than the first length.

16. The catheter according to Claim 15, wherein the third length is least 2 mm and is less than the second length.

17. The catheter according to Claim 16, wherein the first length is 4 mm.

18. The catheter according to Claim 17, wherein the first electrode is separated from the second electrode and the third electrode by an equal distance.

19. The catheter according to Claim 18, wherein the equal distance is 1 mm.

20. The catheter according to Claim 18, wherein the first electrode is farther in distance from a root of the annular ring than the second electrode and the third electrode.

21. The catheter according to Claim 11, wherein the electrode group comprises less than four electrodes.

22. A controller, comprising:

a housing comprising:

a connection port disposed along a surface of the housing, the connection port configured to interface with a catheter comprising a first electrode of a first length,

an electronic display disposed along the surface of the housing,

wherein the housing envelops an electronic data store and a computing device;

the electronic display configured to present a user interface;

the electronic data store comprising stored patient profiles characterizing a plurality of patients; and

the computing device including one or more processors, the computing device in communication with the electronic data store, and the electronic display, the computing device configured to at least:

receive a selection of a first patient profile of the stored patient profiles from the user interface,

display information characterizing the first patient profile on the user interface,

direct power at a first power level sufficient for ablation using the first electrode to the first electrode.

23. The controller of Claim 22, wherein the first power level is based on the first patient profile.

24. The controller of Claim 22, wherein the catheter comprises a second electrode of a second length different than the first length.

25. The controller of Claim 24, wherein the computing device configured to at least direct power at a second power level sufficient for ablation using the second electrode to the second electrode, the second power level based on the first patient profile, the second power level different than the first power level.

26. The controller of Claim 22, further comprising a battery configured to store power at the first power level sufficient for ablation using the first electrode, wherein:

the housing envelops the battery, and

the computing device is in communication with the battery and configured to direct power from the battery at the first power level sufficient for ablation using the first electrode to the first electrode.

27. The controller of 26, wherein the housing comprises a power connection port configured to receive power at a level sufficient to charge the battery.

28. The controller of Claim 27, wherein the computing device is configured to direct power from the battery to the first electrode after the battery has finished charging.

29. The controller of Claim 27, wherein the computing device is configured to direct power to the first electrode before the battery has finished charging.

30. The controller of Claim 22, wherein the catheter comprises a first sensor connected with the first electrode.

31. The controller of Claim 30, wherein the computing device is further configured to display on the user interface first electrode ablation information captured by the first sensor while the first electrode receives power from the battery.

32. The controller of Claim 31, wherein the computing device is further configured to store the first electrode ablation information with the first patient profile.

33. The controller of Claim 32, wherein the first electrode ablation information comprises a temperature.

34. The controller of Claim 22, wherein the catheter comprises an annular ring shaped with an oval comprising a major axis and a minor axis, wherein the major axis comprises a first diameter along the major axis longer than a second diameter along the minor axis, wherein the first electrode straddles the apex of the major axis.

35. A computer-implemented method comprising:

under control of one more computing devices executing specific computer-executable instructions,

receiving a selection of a first patient profile of a plurality of stored patient profiles from a user interface presented on an electronic display disposed across a surface of a housing, the housing comprising a catheter connection port disposed along a surface of the housing, the connection port configured to interface with a catheter comprising a first electrode, the housing enveloping an electronic data store and the one or more computing devices executing specific computer-executable instructions, the electronic data store comprising the plurality of stored patient profiles characterizing a plurality of patients;

displaying information characterizing the first patient profile on the user interface;

receiving a selection of the first patient profile from the user interface,

determining, from the first patient profile, a first power level sufficient for ablation using the first electrode; and

directing power at the first power level to the first electrode.

36. The method of Claim 35, wherein the first electrode is configured to convert the power to radiofrequency (RF) energy for ablation of sympathetic nerve fibers.

37. The method of Claim 35, wherein the first electrode is configured to convert the power to ultrasonic energy for ablation of sympathetic nerve fibers.

38. The method of Claim 35, wherein the first electrode is configured to convert the power to electroporation energy for ablation of sympathetic nerve fibers.

39. The method of Claim 35, wherein the first electrode is configured to convert the power to ionizing energy for ablation of sympathetic nerve fibers.

40. A computer-readable, non-transitory storage medium storing computer executable instructions that, when executed by one or more computer systems, configure the one or more computer systems to perform operations comprising:

receiving a selection of a first patient profile of a plurality of stored patient profiles from a user interface presented on an electronic display disposed across a surface of a housing, the housing comprising a catheter connection port disposed along a surface of the housing, the connection port configured to interface with a catheter comprising a first electrode of a first length, and a second electrode of a second length different than the first length, the housing enveloping an electronic data store and the one or more computer systems, the electronic data store comprising the plurality of stored patient profiles characterizing a plurality of patients;

displaying information characterizing the first patient profile on the user interface;

receiving a selection of the first patient profile from the user interface,

determining, from the first patient profile, a first power level sufficient for ablation using the first electrode;

determining, from the first patient profile, a second power level sufficient for ablation using the second electrode;

directing power at the first power level to the first electrode; and

directing power at the second power level to the second electrode.

41. The computer-readable, non-transitory storage medium of Claim 40, wherein the directing power to the second electrode directs an amount of power greater than an amount of power directed to the first electrode.

42. A multi-pole synchronous pulmonary artery radiofrequency ablation catheter, comprising:

a control handle including an adjustment apparatus;

a catheter body being hollow and comprising a cavity arranged in the catheter body; and

an annular ring;

wherein one end of the catheter body is flexible, and the flexible end is connected to the annular ring, and wherein the other end of the catheter body is connected to the control handle;

wherein one end of the pull wire is connected to the flexible end, and the other end of the pull wire is connected to the adjustment apparatus on the control handle, wherein the adjustment apparatus adjusts the tension of the pull wire to change a curvature of the flexible end;

wherein a shape memory wire is arranged in the annular ring, and one end of the shape memory wire extends to an end of the annular ring and the other end of the shape memory wire passes through a root of the annular ring and is fixed on the flexible end of the catheter body; and

wherein the annular ring is shaped with an oval comprising a major axis and a minor axis, wherein the major axis comprises a first diameter along the major axis longer than a second diameter along the minor axis.

43. The multi-pole synchronous pulmonary artery radiofrequency ablation catheter according to Claim 42, wherein the annular ring, extending from the root of the annular ring to the end of the annular ring, comprises a curve of less than 360 degrees.

44. The multi-pole synchronous pulmonary artery radiofrequency ablation catheter according to Claim 42, wherein the annular ring comprises an electrode that straddles the apex of the major axis.

45. A catheter, comprising:

a catheter body; and

an annular ring, wherein one end of the catheter body is flexible and connected to the annular ring,

wherein the annular ring is oval shaped.

46. The catheter according to Claim 45, wherein the annular ring comprises a major axis and a minor axis, the major axis comprising a first diameter along the major axis longer than a second diameter along the minor axis.

47. The catheter according to Claim 46, wherein the first diameter is 5 mm longer than the second diameter.

48. The catheter according to Claim 46, wherein the major axis is along a first axis of symmetry and the minor axis is along a second axis of symmetry.

49. The catheter according to Claim 46, wherein the annular ring comprises an electrode that straddles the apex of the major axis.

50. The catheter according to Claim 46, wherein the annular ring is orthogonal to the end of the catheter body that is flexible.

51. The catheter according to Claim 46, wherein the annular ring is planar.

52. The catheter according to Claim 46, wherein the annular ring comprises a curve of less than 360 degrees.

53. The catheter according to Claim 46, wherein the annular ring comprises an electrode group comprising a first electrode of a first length, a second electrode of a second

length different than the first length, and a third electrode of a third length different than the first length and different than the second length.

54. The catheter according to Claim 53, wherein the electrodes of the electrode group are substantially coplanar.

55. The catheter according to Claim 53, wherein the annular ring comprises a curve of less than 360 degrees and greater than 270 degrees.

56. The catheter according to Claim 53, wherein the first length is least 4 mm.

57. The catheter according to Claim 56, wherein the second length is least 3 mm and is less than the first length.

58. The catheter according to Claim 57, wherein the third length is least 2 mm and is less than the second length.

59. The catheter according to Claim 58, wherein the first length is 4 mm.

60. The catheter according to Claim 53, wherein the first electrode is separated from the second electrode and the third electrode by an equal distance.

61. A method of performing pulmonary denervation comprising:

positioning an ablation device in a pulmonary artery trunk of a live animal, the pulmonary artery trunk including a distal portion of a main pulmonary artery, a proximal portion of a left pulmonary artery, and a proximal portion of a right pulmonary artery;

deploying an annular ring from the ablation device, the annular ring comprising a major axis and a minor axis, the major axis comprising a first diameter along the major axis longer than a second diameter along the minor axis; and

ablating at least one of the distal portion of the main pulmonary artery, the proximal portion of the left pulmonary artery and the proximal portion of the right pulmonary artery.

62. A controller, comprising:

a housing comprising:

a connection port disposed along a surface of the housing, the connection port configured to interface with a catheter comprising a first electrode of a first length, and a second electrode of a second length different than the first length,

a user interface disposed along the surface of the housing,

wherein the housing envelops an electronic data store and a computing device;

the user interface;

the electronic data store; and

the computing device including one or more processors, the computing device in communication with the electronic data store, and the user interface, the computing device configured to at least:

receive a selection of the first electrode from the user interface,

direct power at a first power level sufficient for ablation using the first electrode to the first electrode,

receive a selection of the second electrode from the user interface, and

direct power at a second power level sufficient for ablation using the second electrode to the second electrode.

63. The controller of Claim 62, wherein the computing device is configured to direct power to the first electrode and direct power to the second electrode at a same time.

64. The controller of Claim 62, wherein the computing device is configured to direct power to the first electrode and direct power to the second electrode at different times.

65. The controller of Claim 62, wherein the computing device is configured to interrupt power directed to the first electrode and direct power to the second electrode after the power directed from the battery to the first electrode is interrupted.

66. The controller of Claim 62, wherein the catheter comprises an annular ring shaped with an oval comprising a major axis and a minor axis, wherein the major axis comprises a first diameter along the major axis longer than a second diameter along the minor axis, wherein the first electrode straddles the apex of the major axis.

67. The controller of Claim 62, further comprising a battery configured to store power at the first power level sufficient for ablation using the first electrode or the second power level sufficient for ablation using the second electrode, wherein:

the housing envelops the battery, and

the computing device is in communication with the battery and configured to:

direct power from the battery at the first power level sufficient for ablation using the first electrode, and

direct power from the battery at the second power level sufficient for ablation using the second electrode.

68. The controller of Claim 67, wherein the housing comprises a power connection port configured to receive power at a level sufficient to charge the battery.

69. The controller of Claim 68, wherein the computing device is configured to direct power from the battery to the first electrode after the battery has finished charging.

70. The controller of Claim 68, wherein the computing device is configured to direct power from the battery to the second electrode after the battery has finished charging.

71. The controller of Claim 62, wherein the catheter comprises a first sensor connected with the first electrode.

72. The controller of Claim 71, wherein the computing device is further configured to display on the user interface first electrode ablation information captured by the first sensor while the computing device directs power to the first electrode.

73. The controller of Claim 62, wherein the catheter comprises a first sensor connected with the first electrode and a second sensor connected with the second electrode.

74. The controller of Claim 73, wherein the computing device is further configured to display on the user interface first electrode ablation information captured by the first sensor while the computing device directs power to the first electrode and second electrode ablation information captured by the second sensor while the computing device directs power to the second electrode.

75. The controller of Claim 74, wherein the second electrode ablation information is displayed on the user interface after the computing device stops directing power to the first electrode.

76. A computer-implemented method comprising:

under control of one more computing devices executing specific computer-executable instructions,

receiving a selection of a first electrode on a user interface disposed across a surface of a housing, the housing comprising a catheter connection port disposed along a surface of the housing, the connection port configured to interface with a catheter comprising a first electrode of a first length, and a second electrode of a second length different than the first length, the housing enveloping an electronic data store and the one or more computing devices executing specific computer-executable instructions;

directing power at a first power level sufficient for ablation using the first electrode to the first electrode;

receiving a selection of the second electrode from the user interface; and

switching from directing power to the first electrode to directing power at a second power level sufficient for ablation using the second electrode to the second electrode.

77. The method of Claim 76, wherein the switching is performed using a mechanical switch that comprises at least one moving part.

78. The method of Claim 77, wherein the user interface is a rotatable knob.

79. The method of Claim 76, wherein the switching is performed using a switching system comprising:

a mechanical switch that comprises at least one moving part, and

a solid state switch that comprises no moving parts.

80. A computer-readable, non-transitory storage medium storing computer executable instructions that, when executed by one or more computer systems, configure the one or more computer systems to perform operations comprising:

receiving a selection of a first electrode from a user interface presented on an electronic display disposed across a surface of a housing, the housing comprising a catheter connection port disposed along a surface of the housing, the connection port configured to interface with a catheter comprising a first electrode of a first length, and a second electrode of a second length different than the first length, the housing enveloping an electronic data store and the one or more computer systems;

directing power at a first power level sufficient for ablation using the first electrode to the first electrode;

receiving a selection of the second electrode from the user interface, and

switching from directing power to the first electrode to directing power at a second power level sufficient for ablation using the second electrode to the second electrode.

81. The computer-readable, non-transitory storage medium of Claim 80, wherein the switching is performed by controlling a solid state switch that comprises no moving parts.

WHAT IS CLAIMED IS:

1. A device for ablating a target tissue of a patient, the device comprising:

a catheter body comprising a proximal end and a terminal distal end;

an elliptical ring coupled to the terminal distal end of the catheter body, the elliptical ring having a major axis and a minor axis, wherein the minor axis divides the elliptical ring into a first portion and a second portion, the first portion encompassing an apex of the major axis; and

a plurality of electrodes supported by the elliptical ring,

wherein a number of electrodes supported by the first portion of the elliptical ring exceeds a number of electrodes supported by the second portion of the elliptical ring.

2. The device according to claim 1, wherein the major axis comprises a first diameter and the minor axis comprises a second diameter, and wherein the first diameter is 5 mm longer than the second diameter.

3. The device according to claim 1, wherein at least one electrode of the plurality of electrodes is disposed over the apex of the major axis.

4. The device according to claim 1, wherein the plurality of electrodes straddle both sides of the apex of the major axis.

5. The device according to claim 1, wherein the distal end of the catheter body is flexible, and wherein the elliptical ring is orthogonal to the distal end.

6. The device according to claim 1, wherein the elliptical ring is planar.

7. The device according to claim 1, wherein the elliptical ring comprises a curve of less than 360 degrees.

8. The device according to claim 1, wherein the plurality of electrodes comprises a first electrode of a first length, a second electrode of a second length different than the first length, and a third electrode of a third length different than the first length and different than the second length.

9. The device according to claim 8, wherein the first, second, and third electrodes are substantially coplanar.

10. The device according to claim 8, wherein the elliptical ring comprises a curve of less than 360 degrees and greater than 270 degrees.

11. The device according to claim 8, wherein the first length is about 4 mm, and optionally wherein the second length is at least 3 mm and is less than the first length, and further optionally wherein the third length is at least 2 mm and is less than the second length.

12. The device according to claim 8, wherein the first electrode is separated from the second electrode and the third electrode by an equal distance.

13. The device according to claim 1, wherein the major axis comprises a first diameter having a length from about 25 mm to about 50 mm, and wherein the minor axis comprises a second diameter shorter than the first diameter and having a length of about 20 mm to about 45 mm.

14. The device according to claim 13, wherein the length of the second diameter is about 10% to about 20% shorter than the length of the first diameter.