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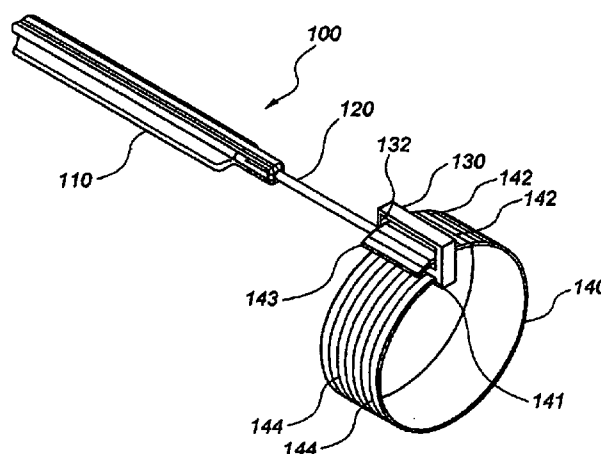


FIG. 2

(57) Abstract: An apparatus comprising a blood vessel measuring device is disclosed. The blood vessel measuring device may comprise a handle. A measuring member may be attached to the handle. The measuring member may be dimensioned to wrap around a blood vessel to measure a size of the blood vessel. The blood vessel measuring device may comprise an extension, and a first end of the extension may be attached to the handle. The blood vessel measuring device may comprise a connector attached to a second end of the extension. A method is also disclosed. The method may comprise inserting a measuring device into an incision in a patient. The measuring device may comprise a measuring member. The method may also comprise wrapping the measuring member around a blood vessel of the patient and measuring a dimension of the blood vessel with the measuring member.



APPARATUS AND METHOD FOR MEASURING BLOOD VESSELS

[0001] This application claims the benefit of U.S. Patent Application No. 12/340,382, filed December 19, 2008, which is hereby incorporated by reference herein in its entirety.

BACKGROUND

[0002] Aortic valve replacement is a cardiac surgery procedure that replaces a patient's aortic valve with a prosthetic valve. Aortic valve replacement typically requires open heart surgery, which may be risky and/or impractical for many patients. Aortic valve replacement may not be an option for patients with aortic stenosis, left ventricular outflow obstruction, a heavily calcified ascending aorta, a heavily calcified aortic root, and/or other high risk medical conditions. For example, patients with conditions that preclude a median sternotomy may not be candidates for an aortic valve replacement operation.

[0003] Apical aortic conduits may provide a less invasive alternative to aortic valve replacement. An apical aortic conduit may be connected between the apex of the heart and the aorta in a procedure similar to a coronary artery bypass graft. Apical aortic conduits may improve blood flow between the heart and the aorta by bypassing a diseased or malfunctioning aortic valve. Patients who are not eligible for aortic valve replacement may be treated by using an apical aortic conduit to bypass the valve. For example, apical aortic conduits may be used in pediatric patients. The native valve may be left in place in pediatric patients to eliminate the

need for periodic valve replacements as the patient grows. Thus, the apical aortic conduit may maintain the maximum possible function of the native valve while bypassing the restricted flow to lessen stress on the heart and allow more blood flow to the body. In other words, the apical aortic conduit may bypass the native valve to allow for extra flow to the aorta while still allowing the maximum flow that the native valve can physiologically handle.

[0004] Traditional apical aortic conduits may fail or malfunction for various reasons. For example, the conduit material used in an apical aortic conduit may become blocked as a result of kinking. Traditional conduits may also become occluded and obstruct apical flow. Also, apical aortic conduits are typically sutured to the heart and the aorta, and the suturing may cause aneurisms at or near the attachment site. Apical aortic conduits may also cause gastrointestinal complications such as dysphagia and gastric erosion.

SUMMARY

[0005] In various embodiments, an apparatus may comprise a blood vessel measuring device. The blood vessel measuring device may comprise a handle and a measuring member attached to the handle, and the measuring member may be dimensioned to wrap around a blood vessel to measure the size of the blood vessel. According to some embodiments, the blood vessel measuring device may comprise an extension with first and second ends. The first end may be attached to the handle and the second end may be attached to the measuring member.

[0006] According to at least one embodiment, the extension may comprise a shape memory material. In some embodiments, the measuring member may comprise a measuring tape. The measuring tape may comprise a shape memory material. According to various embodiments, the measuring member may comprise at least one of a self-expanding or a self-collapsing material.

[0007] According to certain embodiments, the blood vessel measuring device may comprise an extension and a connector. The connector may attach a first end of the measuring member to the extension, and the connector may comprise an opening dimensioned to receive a second end of the measuring member. In some embodiments, the measuring member may comprise a cylinder of shape memory material. According to at least one embodiment, the measuring member may comprise at least one of a circular shape or an elliptical shape.

[0008] In various embodiments, a method may comprise inserting a measuring device into an incision in a patient. The measuring device may comprise a measuring member. The method may also comprise wrapping the measuring member around a blood vessel of the patient and measuring a dimension of the blood

vessel with the measuring member. According to at least one embodiment, the method may comprise placing the measuring member near the blood vessel in an expanded position. The method may further comprise releasing the measuring member to allow the measuring member to collapse to a closed position around the blood vessel.

[0009] In some embodiments, the dimension may be a circumference of the blood vessel. According to at least one embodiment, the dimension may be a width of a region available for attaching a connector to the blood vessel. In various embodiments, the measuring member may be attached to a handle. According to certain embodiments, a connector may attach a first end of the measuring member to an extension, and the connector may comprise an opening dimensioned to receive a second end of the measuring member.

[0010] In various embodiments, a blood vessel measuring device may comprise a handle and an extension. A first end of the extension may be attached to the handle, and a connector may be attached to a second end of the extension. A measuring member may be attached to the connector, and the measuring member may be dimensioned to wrap around a blood vessel to measure the size of the blood vessel.

[0011] According to various embodiments, the connector may comprise an opening dimensioned to receive a second end of the measuring member. In at least one embodiment, the measuring member may comprise circumferential measuring marks for measuring a circumference of the blood vessel. According to some embodiments, the measuring member may comprise width measuring marks for measuring a width of a region available for attaching a connector to the blood vessel.

In some embodiments, the extension may comprise a shape memory material and the measuring member may comprise a measuring tape.

[0012] Features from any of the above-mentioned embodiments may be used in combination with one another in accordance with the general principles described herein. These and other embodiments, features, and advantages will be more fully understood upon reading the following detailed description in conjunction with the accompanying drawings and claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The accompanying drawings illustrate a number of exemplary embodiments and are part of the specification. Together with the following description these drawings demonstrate and explain various principles of the instant disclosure.

[0014] FIG. 1 is a perspective view of an exemplary cardiovascular conduit system attached to a heart according to certain embodiments.

[0015] FIG. 2 is a perspective view of an exemplary blood vessel measuring device according to certain embodiments.

[0016] FIG. 3 is a perspective view of the blood vessel measuring device illustrated in FIG. 2.

[0017] FIG. 4 is a perspective view of a blood vessel measuring device being inserted into an incision according to certain embodiments.

[0018] FIG. 5 is a perspective view of a measuring member of the blood vessel measuring device being placed around an aorta according to certain embodiments.

[0019] FIG. 6 is a perspective view showing measuring of an aorta with the blood vessel measuring device shown in FIG. 5.

[0020] FIG. 7 is a perspective view of an exemplary blood vessel measuring device according to certain embodiments.

[0021] FIG. 8 is a perspective view of an exemplary blood vessel measuring device according to certain embodiments.

[0022] Throughout the drawings, identical reference characters and descriptions indicate similar, but not necessarily identical, elements. While the

exemplary embodiments described herein are susceptible to various modifications and alternative forms, specific embodiments have been shown by way of example in the drawings and will be described in detail herein. However, the exemplary embodiments described herein are not intended to be limited to the particular forms disclosed. Rather, the instant disclosure covers all modifications, equivalents, and alternatives falling within the scope of the appended claims.

DETAILED DESCRIPTION

[0023] Throughout the drawings, identical reference characters and descriptions indicate similar, but not necessarily identical, elements. While embodiments of the instant disclosure are susceptible to various modifications and alternative forms, specific embodiments have been shown by way of example in the drawings and will be described in detail herein. However, one of skill in the art will understand that embodiments of the instant disclosure are not intended to be limited to the particular forms disclosed herein. Rather, the instant disclosure covers all modifications, equivalents, and alternatives falling within the scope of embodiments defined by the appended claims.

[0024] A physician may implant a cardiovascular conduit system to circumvent a restriction in blood flow. For example, a physician may use a cardiovascular conduit system to bypass an aortic valve in a patient with aortic valve stenosis. Similarly, a cardiovascular conduit system may be used to bypass a pulmonary valve in a patient with pulmonary valve stenosis. Physicians may also use cardiovascular conduit systems to address various other problems and diseases in a patient's cardiovascular system.

[0025] Cardiovascular conduit systems may provide various advantages over prior systems. Physicians may implant a cardiovascular conduit system on a beating heart. Procedures performed on a beating heart may be referred to as off-pump procedures, and off-pump procedures may be less invasive than on-pump procedures (*i.e.*, procedures that require cardiopulmonary bypass). In some embodiments, cardiovascular conduit systems may be used with traditional surgical techniques (*e.g.*, on-pump procedures). In traditional surgical techniques, cardiovascular conduit systems may provide various advantages, such as reduced pump time and smaller incisions. Connectors in a cardio-vascular conduit system may be designed to reduce the risk of aneurisms at the attachment site. The conduit in a cardiovascular conduit system may be kink and occlusion resistant. Cardiovascular conduit systems may also reduce the risk of gastrointestinal complications. The following disclosure presents numerous other features and advantages of cardiovascular conduit systems.

[0026] FIG. 1 shows a cardiovascular conduit system 20 connecting a left ventricle 12 of a heart 10 to an aorta 14. Conduit system 20 may include a connector 28 attached to an apex of heart 10. Connector 28 may also be attached to a first end of a conduit section 23. Various examples of cardiovascular conduits and connectors are shown and discussed in U.S. Patent Application No. 12/340,280, filed on 19 December 2008, and entitled "Systems, Apparatuses, and Methods for Cardiovascular Conduits and Connectors," the disclosure of which is incorporated in its entirety in this reference.

[0027] A second end of conduit section 23 may be attached to a connector 21, and connector 21 may be attached to a first end of a conduit section 24. A

second end of conduit section 24 may be attached to a valve housing 22 that includes a valve 19. Valve 19 may control the flow of blood between left ventricle 12 and aorta 14. Various examples of valves and valve housings are illustrated and described in U.S. Patent Application No. 12/340,189, filed on 19 December 2008, and entitled "Cardiovascular Valve and Valve Housing Apparatuses and Systems," the disclosure of which is incorporated in its entirety by this reference.

[0028] Valve housing 22 may also be connected to a first end of a conduit section 25, and a second end of conduit section 25 may be attached to a connector 29. A first end of a conduit section 27 may be attached to connector 29, and a second end of conduit section 27 may be attached to a connector 26. Connector 26 may attach conduit section 27 to aorta 14. The conduit system shown in FIG. 1 may be referred to as an apical aortic conduit system because it connects an apex of heart 10 (at left ventricle 12) to aorta 14.

[0029] According to various embodiments, several sizes of cardiovascular-conduit-system connectors may be available to a physician. In order to select the best aortic connector for use with a particular patient, a physician may determine the size of the patient's aorta. Typical aortas may range from 20-50 millimeters (mm) in diameter, and some patients' aortas may be smaller than 20 mm or larger than 50 mm. An aortic connector that is too large for a patient's aorta may not fit into the aorta properly. On the other hand, an aortic connector that is too small may not provide optimal blood flow. The blood vessel measuring devices and methods disclosed herein may allow a physician to determine the size of a patient's aorta and avoid the problems associated with improperly sized connectors.

[0030] A physician may measure the size of a patient's aorta (or other blood vessel) to determine the appropriately sized connector, conduit, valve, cutting device (*e.g.*, coring device), tube, and/or other tools for implanting a cardiovascular conduit system. Various examples of cutting devices and valves are illustrated and described in U.S. Patent Application No. 12/340,431, filed on 19 December 2008, and entitled "Systems, Apparatuses, and Methods for Cardiovascular Cutting Devices and Valves," the disclosure of which is incorporated in its entirety by this reference.

[0031] Blood vessels may be any veins or arteries in a cardiovascular system. Blood vessel measuring devices disclosed herein may be designed to measure large blood vessels such as the aorta and/or the pulmonary artery. Blood vessel measuring devices may also be designed to measure various other blood vessels.

[0032] FIG. 2 illustrates a blood vessel measuring device 100. Blood vessel measuring device 100 may include a handle 110, an extension 120, a connector 130, and a circular measuring member 140. Measuring member 140 may include measuring marks 142, which may be in increments of centimeters, inches, or any other suitable measurement unit. A physician may use measuring marks 142 to determine the circumference of a patient's blood vessel. Thus, measuring marks 142 may be referred to as circumferential measuring marks. A physician may determine the circumference of a patient's blood vessel by positioning measuring member 140 around a patient's aorta and reading measuring marks 142, as will be discussed in the disclosure corresponding to FIGS. 3-6.

[0033] Handle 110 may be attached to extension 120, and extension 120 may be attached to connector 130, as shown in FIG. 2. In other embodiments, handle 110 may be directly attached to connector 130 or measuring member 140. Handle 110 may be any suitable shape and/or size. According to some embodiments, handle 110 may be ergonomically shaped for optimal surgeon control and comfort. Handle 110 may be made of any suitable material. In some embodiments, handle 110 may be brightly colored to help the physician see and guide blood vessel measuring device 100 during a procedure. Handle 110 may be textured to provide slip resistance. In some embodiments, handle 110 may be made of a shape memory material that allows handle 110 to be flexible, which may help a physician properly position blood vessel measuring device 100 for measuring a patient's aorta or other blood vessel.

[0034] As previously noted, extension 120 may attach handle 110 to connector 130. Extension 120 may be a rod, bar, or shaft of any suitable shape and/or size. Extension 120 may be made of a shape memory material or any other suitable material. Shape memory materials may include shape memory alloys, which may also be referred to as smart alloys or memory metals. A shape memory material may be a copper-zinc-aluminum alloy, a copper-aluminum-nickel alloy, a nickel-titanium alloy (*e.g.*, NITINOL), or any other suitable shape memory alloy. The flexibility of extension 120 may help a physician properly position blood vessel measuring device 100 for measuring a blood vessel.

[0035] FIG. 2 shows that connector 130 may attach extension 120 to an end 141 of measuring member 140. An end 143 of measuring member 140 may extend through an opening 132 in connector 110. Opening 132 may help a physician

determine the circumference of a blood vessel. For example, a physician may determine a circumference of the blood vessel by reading the measuring mark on end 143 that is closest to opening 132.

[0036] Measuring member 140 may be a measuring tape or any other suitable measuring device. Measuring member 140 may be semi-rigid and may be made of any suitable material, including plastic or metal. Measuring member 140 may also be made of a shape memory material. In some embodiments, measuring member 140 may be reinforced with plastic or metal inserts to provide additional rigidity. The rigidity of measuring member 140 may help measuring member 140 return from an open position (*i.e.*, a position where end 143 is pulled out of opening 132 and away from connector 130) to a closed position (*i.e.*, a position where end 143 passes through opening 132).

[0037] As previously noted, measuring member 140 may include marks 142 for taking circumferential measurements. Marks 142 may allow a physician to measure the circumference of a blood vessel and determine a diameter of the blood vessel. Measuring member 140 may also include marks 144 for taking width measurements. In some embodiments, marks 144 may be horizontal to marks 142. Marks 144 may be in increments of centimeters, inches, or any other suitable measurement unit. Marks 144 may help a physician determine how much space is available (*e.g.*, a width of a region available) for attaching a connector to the blood vessel.

[0038] Marks 142 and 144 may be any type of suitable measuring indication. In some embodiments, marks 142 and/or 144 may be lines with corresponding measurement numbers. According to various embodiments, marks

142 and/or 144 may be indents or bumps. In such embodiments, a physician may be able to determine an aorta's size by feeling, rather than reading, marks 142 and/or 144.

[0039] Measuring member 140 may be designed to measure a blood vessel as the diameter of the blood vessel changes due to systolic and diastolic pressures. The diameter of a blood vessel may change ten to fifteen percent under systolic and diastolic pressures. The diameter of a blood vessel may also change less than ten or more than fifteen percent under systolic and diastolic pressures, and measuring member 140 may be designed to accommodate these diameter fluctuations.

[0040] Measuring member 140 may be made of a resilient material that maintains constant pressure on the blood vessel as the diameter of the blood vessel changes. For example, measuring member 140 may be made of a shape memory material that applies slight pressure to the blood vessel and changes diameter as the blood vessel changes diameter. A physician may be able to determine both the larger and smaller diameters of the blood vessel, which may enable the physician to choose the most appropriate connector for the blood vessel. In some embodiments, handle 110 may have a gauge (or any other suitable measurement indicator) that displays the diameter and/or circumference of measuring member 140. Thus, a physician may be able to read the gauge to determine the size of the blood vessel as it changes.

[0041] FIG. 3 shows that measuring member 140 may collapse (*e.g.*, wind-up) to allow it to have a smaller diameter. Measuring member 140 may be self-collapsing (*e.g.*, resilient enough to collapse to a certain diameter without the aid of a physician) to a predetermined diameter. Measuring member 140 may also be self-

expanding. The collapsibility of measuring member 140 may allow measuring member 140 to be inserted into a smaller incision. In some embodiments, a physician may hold measuring member 140 in a collapsed position while inserting measuring member 140 into an incision in a user. In other embodiments, blood vessel measuring device 100 may include a retaining member that holds measuring member 140 in a collapsed position for insertion into an incision. A physician may release the retaining member to allow measuring member 140 to expand after measuring member 140 is inserted through the incision. FIG. 4 illustrates blood vessel measuring device 100 being inserted into an incision 50 in a patient. As shown in FIG. 4, blood vessel measuring device 100 may be inserted toward aorta 14.

[0042] FIGS. 5 and 6 show blood vessel measuring device 100 with measuring member 140 placed around aorta 14. A physician may wrap measuring member 140 around aorta 14. In some embodiments, measuring member 140 may be made of a shape memory material (or any other suitable resilient material) that springs into a closed position from an open position. Thus, a physician may place measuring member 140 partially around aorta 14, as shown in FIG. 5, and then release measuring member 140. After being released, measuring member 140 may spring to a closed measuring position (as shown in FIG. 6) without additional help from the physician.

[0043] The physician may tighten measuring member 140 until it is snug around aorta 14 and capable of measuring the diameter of aorta 14. In various embodiments, measuring member 140 may be resilient enough that it tightens around aorta 14 without additional tightening by the physician. After measuring member

140 is tightened around aorta 14, the physician may look at marks 142 to determine the size of aorta 14. In other embodiments, the physician may use a biomedical optical device to view marks 142 on measuring member 140. According to at least one embodiment, blood vessel measuring device 100 may include an electronic measurement system in addition to or instead of marks 142 and 144. For example, blood vessel measuring device 100 may include a button on handle 110. When a physician presses the button, blood vessel measuring device 100 may take a measurement of the circumference and/or diameter of measuring member 140.

[0044] FIG. 6 shows that measuring member 140 may be positioned between arteries 16 and 18. Measuring marks 144 may allow a physician to determine how much space between arteries 16 and 18 is available for inserting a connector (*i.e.*, a physician may read measuring marks 144 to determine a distance between arteries 16 and 18). A physician may choose a connector with a diameter equal to or smaller than the distance between arteries 16 and 18 if the physician desires to place the connector between arteries 16 and 18.

[0045] FIGS. 5 and 6 show that extension 120 may be bendable. A bendable extension, such as extension 120, may help a physician navigate around other organs in the patient to properly position measuring member 140 around the aorta. In some embodiments, extension 120 may be detachable from both handle 110 and connector 130. Extension 120 may be interchangeable with extensions of other shapes and sizes. For example, a physician may use a longer extension for larger patients and a shorter extension for smaller patients.

[0046] FIG. 7 illustrates a blood vessel measuring device 200. As shown in FIG. 7, blood vessel measuring device 200 may include a handle 210, an

extension 220, a connector 230, and a measuring member 240. Measuring member 240 may be a rod instead of having a cylindrical shape like measuring member 140 shown in FIG. 2. As shown in both FIGS. 2 and 7, measuring members may be circular in shape, mirroring the shape of a blood vessel. According to various embodiments, aorta measuring members may have other shapes or may be designed to conform to other shapes (*e.g.*, elliptical shapes) for use with abnormally-shaped blood vessels.

[0047] According to various embodiments, connector 230 and/or measuring member 240 may be transparent or semi-transparent, which may provide a contrast with the indicator marks that allows the physician to more easily read the marks. A transparent or semi-transparent measuring member may also allow the physician to see a surface of the vessel being measured.

[0048] FIG. 8 illustrates a blood vessel measuring device 300 with a handle 310, an extension 320, and a measuring member 330. As shown in FIG. 8, a blood vessel measuring device does not necessarily need to include a connector. In at least one embodiment, extension 320 may be directly connected to measuring member 330. In some embodiments, a blood vessel measuring device may not include a separate handle and extension (*e.g.*, extension 320 may be used as a handle). According to at least one embodiment, blood vessel measuring device 300 may not include extension 320, and handle 310 may be directly attached to measuring member 330.

[0049] Measuring member 330 may be cylindrical, annular, ring-shaped, curved, rounded, and/or circular. Measuring member 330 may expand and collapse to have a diameter 340 that ranges between 15 mm and 55 mm. In some

embodiments, measuring member 330 may expand or collapse to any suitable diameter, including diameters greater than 55 mm or less than 15 mm.

[0050] As previously noted, blood vessel measuring devices may help physicians determine the appropriate size of connectors for their patients. Selecting an appropriately-sized connector may reduce the risk of an aneurism at the connection site of the blood vessel and the connector. A properly-sized connector may also optimize blood flow. Accurately sizing connectors for a blood vessel may reduce leakage around the connector, reduce the possibility of vessel dissection, reduce the risk of connector tear-out, and may improve the speed of the implant procedure.

[0051] The preceding description has been provided to enable others skilled in the art to best utilize various aspects of the exemplary embodiments described herein. This exemplary description is not intended to be exhaustive or to be limited to any precise form disclosed. Many modifications and variations are possible without departing from the spirit and scope of the instant disclosure. It is desired that the embodiments described herein be considered in all respects illustrative and not restrictive and that reference be made to the appended claims and their equivalents for determining the scope of the instant disclosure.

[0052] Unless otherwise noted, the terms “a” or “an”, as used in the specification and claims, are to be construed as meaning “at least one of.” In addition, for ease of use, the words “including” and “having”, as used in the specification and claims, are interchangeable with and have the same meaning as the word “comprising.”

WHAT IS CLAIMED IS:

1. An apparatus comprising:
a blood vessel measuring device comprising:
a handle;
a measuring member attached to the handle, the measuring member being dimensioned to wrap around a blood vessel to measure a size of the blood vessel.
2. The apparatus of claim 1, wherein the blood vessel measuring device comprises:
an extension with first and second ends, the first end being attached to the handle and the second end being attached to the measuring member.
3. The apparatus of claim 2, wherein the extension comprises a shape memory material.
4. The apparatus of claim 1, wherein the measuring member comprises a measuring tape.
5. The apparatus of claim 4, wherein the measuring tape comprises a shape memory material.

6. The apparatus of claim 1, wherein the measuring member comprises at least one of:

a self-expanding material;

a self-collapsing material.

7. The apparatus of claim 1, wherein the blood vessel measuring device comprises:
an extension;

a connector attaching a first end of the measuring member to the extension, the connector comprising an opening dimensioned to receive a second end of the measuring member.

8. The apparatus of claim 1, wherein the measuring member comprises a cylinder of shape memory material.

9. The apparatus of claim 1, wherein the measuring member comprises at least one of:

a circular shape;

an elliptical shape.

10. A method comprising:
inserting a measuring device into an incision in a patient, the measuring device comprising a measuring member;

wrapping the measuring member around a blood vessel of the patient;

measuring a dimension of the blood vessel with the measuring member.

11. The method of claim 10, further comprising:
placing the measuring member near the blood vessel in an expanded position;
releasing the measuring member to allow the measuring member to collapse to a closed position around the blood vessel.
12. The method of claim 10, wherein the dimension is a circumference of the blood vessel.
13. The method of claim 10, wherein the dimension is a width of a region available for attaching a connector to the blood vessel.
14. The method of claim 10, wherein the measuring member is attached to a handle.
15. The method of claim 10, wherein a connector attaches a first end of the measuring member to an extension, and the connector comprises an opening dimensioned to receive a second end of the measuring member.

16. An apparatus comprising:
a blood vessel measuring device comprising:
a handle;
an extension, a first end of the extension being attached to the handle;
a connector attached to a second end of the extension;
a measuring member attached to the connector, the measuring member being
dimensioned to wrap around a blood vessel to measure a size of the blood
vessel.
17. The apparatus of claim 16, wherein the connector comprises an opening
dimensioned to receive a second end of the measuring member.
18. The apparatus of claim 16, wherein the measuring member comprises
circumferential measuring marks for measuring a circumference of the blood vessel.
19. The apparatus of claim 18, wherein the measuring member comprises width
measuring marks for measuring a width of a region available for attaching a connector to the
blood vessel.
20. The apparatus of claim 16, wherein the extension comprises a shape memory
material and the measuring member comprises a measuring tape.

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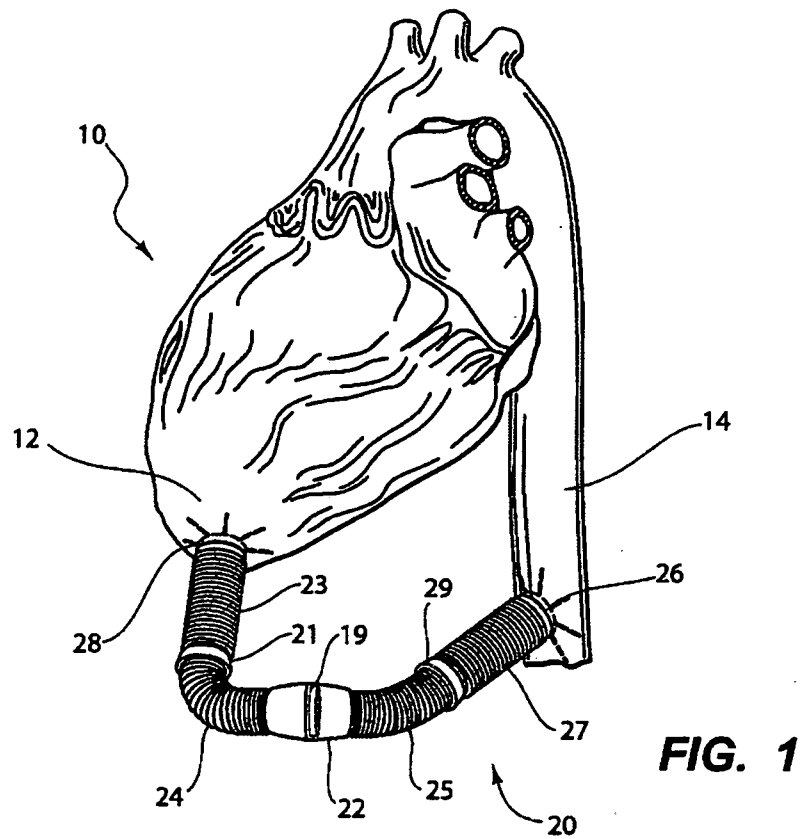


FIG. 1

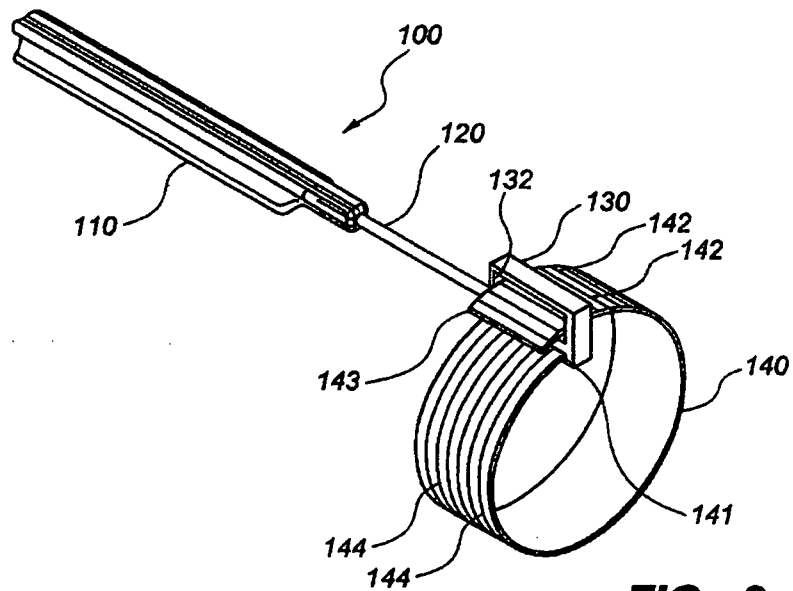


FIG. 2

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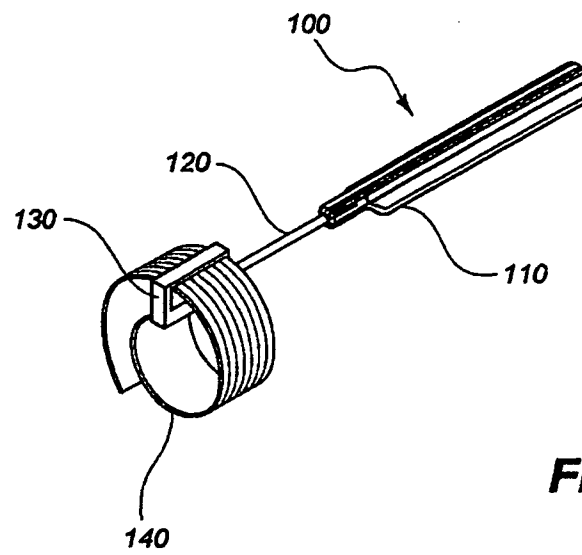


FIG. 3

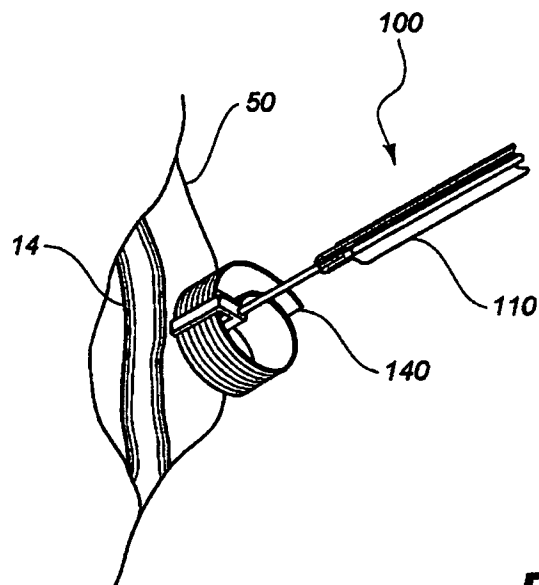


FIG. 4

3 / 4

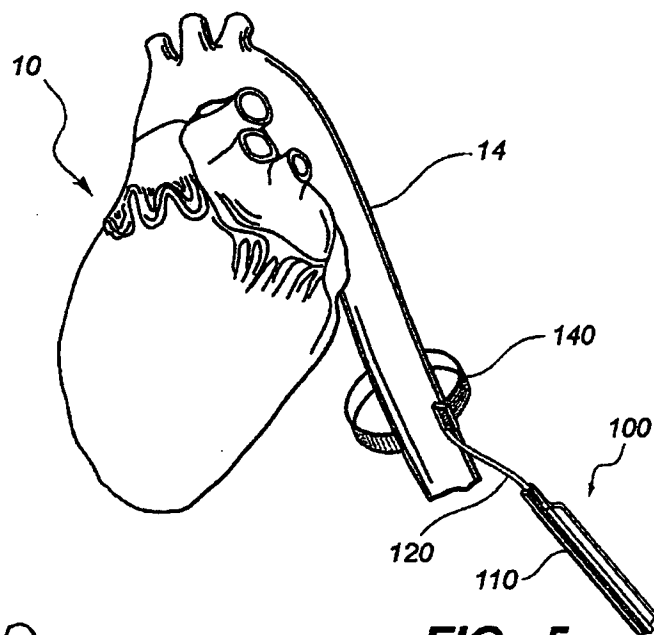


FIG. 5

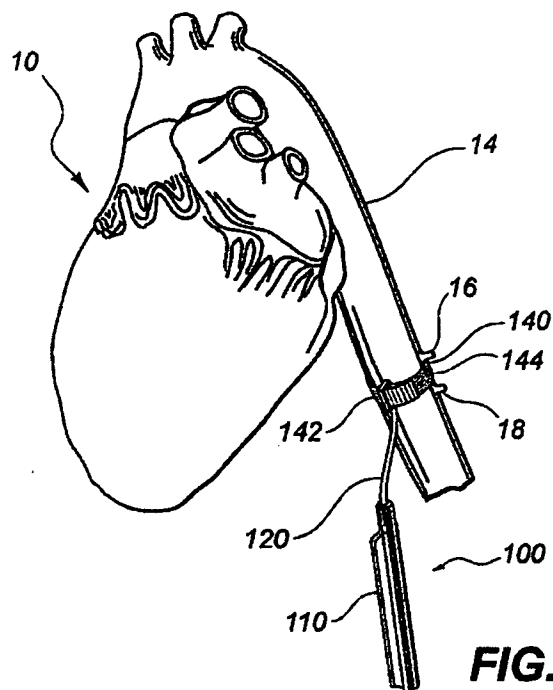


FIG. 6

4 / 4

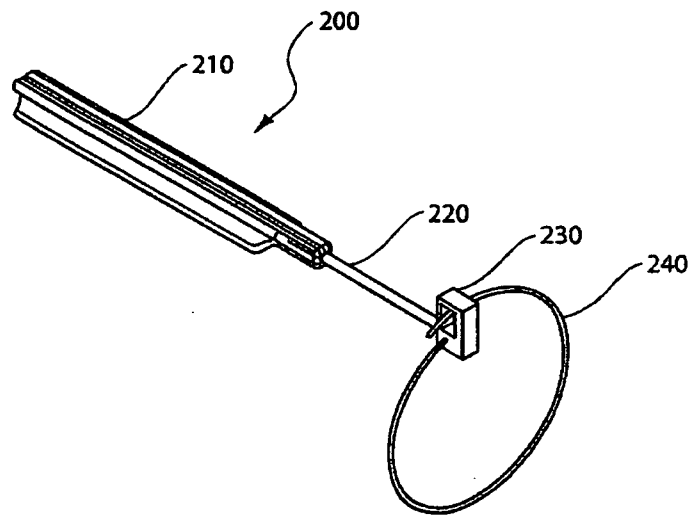


FIG. 7

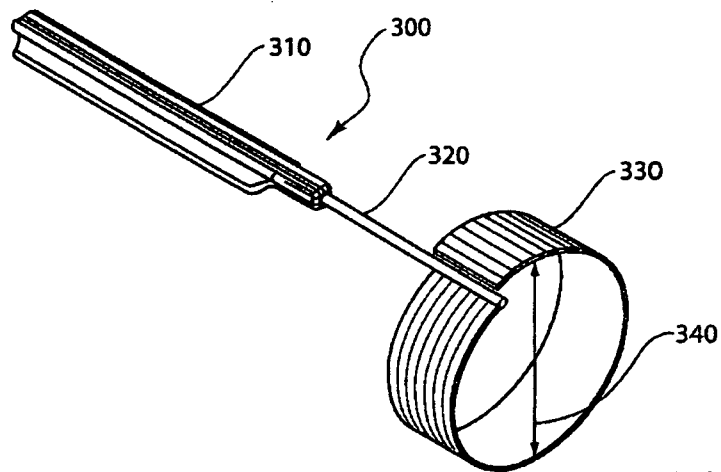


FIG. 8

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2009/006582

A. CLASSIFICATION OF SUBJECT MATTER

INV. A61B5/107

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

A61B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 666 832 B1 (CARRANZA JOSE R [US] ET AL) 23 December 2003 (2003-12-23) column 1, lines 6-8 column 2, lines 21-63 column 3, line 46 - column 4, line 59 column 6, lines 29-63	1,9
Y	US 2008/215134 A1 (LAWRENCE-BROWN MICHAEL [AU]) 4 September 2008 (2008-09-04) paragraphs [0007] - [0017], [0043]; figures 1,2 -/-	1-9, 16-20



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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Date of the actual completion of the international search

19 March 2010

Date of mailing of the international search report

29/03/2010

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Authorized officer

Pohjamo, Terhi

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2009/006582

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT.

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 00/35355 A2 (WILD ANDREW MICHAEL [GB]) 22 June 2000 (2000-06-22) page 1, lines 4-11 page 6, lines 5-16 page 9, lines 14-21 page 18, lines 6-11 page 22, line 13 - page 23, line 26 page 24, line 6 - page 25, line 4 page 36, lines 3-6 figures 1,3,4 -----	1-9, 16-20

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2009/006582

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☒ Claims Nos.: 10-15
because they relate to subject matter not required to be searched by this Authority, namely:
Rule 39.I(iv) PCT - Method for treatment of the human or animal body by surgery
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2009/006582

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