RADIATION CATHETER WITH MULTILAYERED BALLOON

FIELD OF THE INVENTION

[0001] This invention relates generally to the fields of medical treatment devices and methods of use. In particular, the invention relates to devices and methods for irradiating tissue surrounding a body cavity, such as a site from which cancerous, pre-cancerous, or other tissue has been removed.

BACKGROUND OF THE INVENTION

[0002] In diagnosing and treating certain medical conditions, it is often desirable to perform a biopsy, in which a specimen or sample of tissue is removed for pathological examination, tests and analysis. A biopsy typically results in a biopsy cavity occupying the space formerly occupied by the tissue that was removed. As is known, obtaining a tissue sample by biopsy and the subsequent examination are typically employed in the diagnosis of cancers and other malignant tumors, or to confirm that a suspected lesion or tumor is not malignant. Treatment of cancers identified by biopsy may include subsequent removal of tissue surrounding the biopsy site, leaving an enlarged cavity in the patient's body. Cancerous tissue is often treated by application of radiation, by chemotherapy, or by thermal treatment (e.g., local heating, cryogenic therapy, and other treatments to heat, cool, or freeze tissue).

[0003] Cancer treatment may be directed to a natural cavity, or to a cavity in a patient's body from which tissue has been removed, typically following removal of cancerous tissue during a biopsy or surgical procedure. For example, U.S. Pat. No. 6,923,754 to Lubock and U.S. Pat. Application Serial No. 10/849,410 to Lubock, the disclosures of which are all hereby incorporated by reference in their entireties, describe devices for implantation into a cavity resulting from the removal of

cancerous tissue which can be used to deliver radiation to surrounding tissue. One form of radiation treatment used to treat cancer near a body cavity remaining following removal of tissue is "brachytherapy" in which a source of radiation is placed near to the site to be treated.

[0004] Lubock above describes implantable devices for treating tissue surrounding a cavity left by surgical removal of cancerous or other tissue that includes an inflatable balloon constructed for placement in the cavity. Such devices may be used to apply one or more of radiation therapy, chemotherapy, and thermal therapy to the tissue surrounding the cavity from which the tissue was removed. The delivery lumen of the device may receive a solid or a liquid radiation source. Radiation treatment is applied to tissue adjacent the balloon of the device by placing radioactive material such as radioactive "seeds" in a delivery lumen. Such treatments may be repeated if desired.

[0005] For example, a "MammoSite® Radiation Therapy System" (MammoSite® RTS, Proxima Therapeutics, Inc., Alpharetta, GA 30005 USA) includes a balloon catheter with a radiation source or configured to receive a radiation source that can be placed within a tumor resection cavity in a breast after a lumpectomy. It can deliver a prescribed dose of radiation from inside the tumor resection cavity to the tissue surrounding the original tumor. The radiation source is typically a solid radiation source; however, a liquid radiation source may also be used with a balloon catheter placed within a body cavity (e.g., Iotrex®, Proxima Therapeutics, Inc.). A radiation source such as a miniature or microminiature x-ray tube catheter may also be used (e.g. U.S. Patent No. 6,319,188). The x-ray tube catheters are small, flexible and are believed to be maneuverable enough to reach the desired treatment location within a patient's body. The radiation source may be removed following

each treatment session, or may remain in place as long as the balloon remains within the body cavity. Inflatable treatment delivery devices and systems, such as the MammoSite® RTS and similar devices and systems (e.g., GliaSite® RTS (Proxima Therapeutics, Inc.)), are useful to treat cancer in tissue adjacent a body cavity.

[0006] Tissue cavities resulting from biopsy or other surgical procedures such as lumpectomy typically are not always uniform or regular in their sizes and shapes, so that radiation treatment often result in differences in dosages applied to different regions of surrounding tissue, including "hot spots" and regions of relatively low dosage. However, by conforming the tissue lining the cavity about an inflated member, such as a balloon, a more uniform or controlled radiation can be applied to the tissue.

[0007] However, making a robust, inflatable balloon which has a predictable inflated size and shape can be problematic, particularly with a balloon size suitable for breast biopsy/lumpectomy cavities which range from about 0.5 to about 4 inches in maximum diameter, and are typically about 2 inches.

SUMMARY OF THE INVENTION

[0008] This invention is generally directed to irradiating tissue surrounding a patient's body cavity, and particularly to devices and methods for such treatments. The invention is particularly suitable for treating tissue adjacent a patient's body cavity formed by removal of tissue for a biopsy or lumpectomy.

[0009] More specifically, a device embodying features of the invention includes an elongated shaft with a treatment location at a distal portion of the shaft which is configured to receive or which includes a radiation source and an inflatable cavity filling member or balloon surrounding the treatment location on the distal shaft

portion having two or more layers of compliant or semi-compliant polymeric materials. In this embodiment, the polymeric material of one or more of the multiple layers of the inflatable balloon in a formed but un-inflated condition has limited expansion to a turgid inflated condition with the balloon material at or near the material's elastic limit. The balloon's volumetric expansion from an initial formed condition to an inflated turgid condition should be less than 200%, preferably less than 175% and should be more than 25%. Typically, the expansion should be about 50% to about 150%. The residual stress in the formed polymeric material of the one or more layers of the balloon should be the result of an expansion of the external surface area of a balloon to the surface area of the balloon in the initial formed condition. This expansion can be represented by the ratio of the external surface area of the initially formed condition of the balloon to the to-be-expanded external surface area of the balloon preform represented as a percentage of the to-be-expanded surface area of the balloon preform. This ratio should be not more than 1000%, preferably less than 800% from a pre-form such as a tube. Preferably, the pre-form is an extruded product. The process of expansion may involve heating the preform and the level of residual stress in the balloon material at the initial formed condition may be dependent on the temperature of the preform during the expansion and the time dependant profile of the heating and cooling cycle of the material during expansion.

[0010] The multiple layers of the inflatable cavity filling member should be formed of a thermoplastic elastomeric polymer such as polyester polyurethane, e.g. Pellethane™ which is available from Dow Chemical. Preferably the polymeric material has a Shore Durometer of 90A. Other suitable polymeric materials may be

employed. The polymeric material of the balloon layers may be a blend of polymers or a copolymer.

[0011] Balloons of this type are often filled with a radiopaque fluid for visualization for positional and symmetry verification and CT for positional verification and radiation dose planning. The balloons themselves may be radiopaque by compounding radiopaque agents into the balloon material, coating the inside and/or outside surfaces of a balloon layer with radiopaque material or providing a radiopaque material between balloon layers. Radiopaque agents or materials may be one or more metals of the group consisting of tantalum, tungsten, rhenium, titanium and alloys thereof or compounds containing oxides of titanium or barium salts such as those which are often used as pigments.

[0012] A radiation catheter device embodying features of the invention preferably has an inflatable cavity filling member or balloon at the treatment location which is configured to at least in part fill the body cavity to be treated. The device also may include an inner lumen configured to be in fluid communication with a proximal vacuum source and one or more vacuum ports preferably proximal and/or distal to the cavity filling member such as described in U.S. Pat. No. 6,923,754 and co-pending application Serial No. 10/849,410, filed on May 19, 2004, both of which are assigned to the present assignee. Application of a vacuum within the inner lumen aspirates fluid in the cavity through the one or more vacuum ports and the application of a vacuum within the body cavity pulls tissue defining the cavity onto the exterior of the inflated cavity filling member deployed within the cavity so as to conform the tissue lining to the shape of the cavity filling member.

[0013] Methods previously described in co-pending applications Serial No. 11/357,274, filed on February 17, 2006 and Serial No. 11/593,789, filed on

November 6, 2006 for using radiation catheters are suitable for a radiation catheter embodying features of the invention body cavity. The present invention however, provides enhanced control over the expansion of the balloon and a more predictable ultimate balloon size and shape. These and other advantages of the present invention are described in more detail in the following detailed description and the accompanying exemplary drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] Figure 1 is a perspective view of a catheter device embodying features of the invention including a multilayered balloon.

[0015] Figure 2 is a transverse cross section of the catheter shaft taken along the lines 2-2 shown in Figure 1.

[0016] Figure 3 is an enlarged transverse cross sectional view of the multilayered balloon wall shown in Figure 2.

[0017] Figure 4 is an enlarged sectional view of the balloon wall shown in the circle 4-4 in Figure 3 to illustrate the multiple layers thereof.

[0018] Figure 5 is an enlarged longitudinal cross-section of a radiation tube taken along the lines 5-5 shown in Figure 1 to illustrate the deployment of a radiation source within the treatment location.

DETAILED DESCRIPTION OF THE INVENTION

[0019] The present invention provides devices and methods for treatment of a patient's body cavity. For example, devices and methods having features of the invention are used to deliver radiation or other treatment into a biopsy site or into a cavity left after removal of cancerous tissue from the patient's body.

[0020] Figures 1-5 illustrate a catheter device 10 which has an elongated shaft 11, a cavity filling member or balloon 12 on the distal portion of the shaft which for the

most part defines the treatment location, and an adapter 13 on the proximal end of shaft 11. A plurality of tubes 14-18 extend into the adapter 13 and are in fluid communication with lumens 20-24 respectively within the shaft 11 which are configured to receive one or more radiation sources 25. The device 10 also has an inflation tube 26 which is in fluid communication with inflation lumen 27 that extends to and is in fluid communication with the interior of the balloon 12 to facilitate delivery of inflation fluid thereto. The inflation fluid may be radiopaque to facilitate imaging of the balloon and shaft within the patient. The lumen 27 is shown filled with radiopaque fluid in Fig. 1. The adapter 13 also has a vacuum tube 28 that is in fluid communication with lumens 30 and 31. Lumen 30 is in fluid communication with proximal vacuum port 32 and lumen 31 is in fluid communication with tubular member 33 which extends across the interior of balloon 12 and which in turn is in fluid communication with distal vacuum port 34. Radiation delivery tubes 35-39 extend through the interior of balloon 12 and are in fluid communication with lumens 20-24 within shaft 11. The radiation delivery tubes 35, 36, 38 and 39 extend radially away from a center line axis 40 within the interior of balloon 12 in order to position a radiation source 25 closer to a first tissue portion surrounding a body cavity than a second tissue portion. While tubes 35, 36, 38 and 39 are shown as being slightly radially extended within the interior of balloon 12, less than all of them may radially extend within the balloon 12 depending upon the need for a particular treatment. Moreover, tubes 35, 36, 38 and 39 may be in a contracted state within recesses of support member 41, and one or more of the tubes may be radially extended out of the recesses after the balloon 12 is deployed within a cavity at the target body site.

[0021] The support element 41, which extends between the proximal and distal ends of the balloon 12, has four compartments 42-4 which are designed to receive

tubular radiation delivery members 35, 36, 38 and 39 respectively. The radiation delivery tubes will not usually be radially extended to the extent that they contact the interior surface of the balloon 12 in an inflated condition.

[0022] The balloon 12 is provided with two separate layers 50 and 51 as shown in Figure 4. The expansion of the balloon 12 is illustrated in Figure 3 with the balloon in an as formed, non-turgid condition shown in phantom. The arrow 52 illustrates the expansion of the balloon from the formed condition to the turgid condition. The volumetric expansion is less than 200% of the initial formed volume (diameter shown as arrow 53), preferably less than 175% and is typically about 75 to about 125% of the initial balloon volume. While the inflated, turgid balloon 12 is shown as being spherical in shape, other shapes may be suitable, such as an ovoid shape. Depending upon the material and the conditions at the body site, the wall of the turgid balloon may relax somewhat after reaching the turgid condition. The thicknesses of the balloon wall layers can vary depending upon the material characteristics and the number of layers. Typically, the thickness of individual balloon wall layers range from about 0.0003 to about 0.006 inch, preferably about 0.001 to about 0.002 inch. The total thickness of the balloon wall is about 0.0006 to about 0.012 inch, preferably about 0.002 to about 0.004 inch.

[0023] The radiation delivery tubes 14-18, which extend into the adapter 13, may extend through the lumens 20-24 in shaft 11 and may form tubes 35-39 which are received by the support member 40 and extend into the interior of balloon 12.

[0024] All of the radiation delivery tubes which extend through the interior of the balloon 12 would not necessarily be used in a particular irradiation procedure, but they would be available for use by the physician if needed, e.g. when the balloon 12 of the radiation catheter 10 is not in a desired position and rotation of the catheter is

not appropriate or desirable. The shaft 11 is shown as a solid shaft having a plurality of passageways. However, the shaft 11 may be made more flexible by utilizing a plurality of elongated tubes 14-18 which are bundled together to form the shaft. Multiple bands may encircle the tubular members along their length to hold the tubular members together.

[0025] The radiation source 25 for the brachytherapy device 10 is shown as a radiation seed on the distal end of rod 46. However, the radiation source 25 may be a solid or liquid radiation source. Suitable liquid radiation sources include, for example, a liquid containing a radioactive iodine isotope (e.g., I^{125} or I^{131}), a slurry of a solid isotope, for example, ^{198}Au or ^{169}Yb, or a gel containing a radioactive isotope. Liquid radiation sources are commercially available (e.g., Iotrex®, Proxima Therapeutics, Inc., Alpharetta, Ga.). The radiation source 25 preferably includes brachytherapy seeds or other solid radiation sources used in radiation therapy. A catheter with a micro-miniature x-ray source may also be utilized. The radiation source 25 may be either preloaded into the device 10 at the time of manufacture or may be loaded into the device 10 before or after placement into a body cavity or other site of a patient. Solid radionuclides suitable for use with a device 10 embodying features of the present invention are currently generally available as brachytherapy radiation sources (e.g., I-Plant. TM. Med-Tec, Orange City, Iowa.). Radiation may also be delivered by a micro-miniature x-ray device such as described in U.S. Patent No. 6,319,188. The x-ray tubes are small, flexible and are believed to be maneuverable enough to reach the desired location within a patient's body.

[0026] The radiation source 25 of the device 10 can include a radiation source which is solid or liquid or both, e.g. a slurry. Suitable liquid radiation sources include, for example, a liquid containing a radioactive iodine isotope (e.g., I^{125} or I^{131}), a slurry

of a solid isotope, for example, ^{198}AU or ^{169}Yb, or a gel containing a radioactive isotope. Liquid radiation sources are commercially available (e.g., Iotrex®, Proxima Therapeutics, Inc., Alpharetta, Ga.). The radiation source 18 preferably is one or more brachytherapy seeds, for example, a radioactive microsphere available from 3M Company of St. Paul, Minn. Other suitable brachytherapy radiation sources include I-Plant™, (Med-Tec, Orange City, Iowa.). Radiation may also be delivered by a microminiature x-ray tube catheter such as described in U.S. Patent No. 6,319,188. X-ray tube catheters are small, flexible and are believed to be maneuverable enough to reach the desired location within a patient's body.

[0027] The device 10 can be provided, at least in part, with a lubricious coating, such as a hydrophilic material. The lubricious coating preferably is applied to the elongate shaft 11 or to the balloon 12 or both, to reduce sticking and friction during insertion and withdrawal of the device 10. Hydrophilic coatings such as those provided by AST, Surmodics, TUA Systems, Hydromer, or STS Biopolymers are suitable. The surfaces of the device 10 may also include an antimicrobial coating that covers all or a portion of the device 10 to minimize the risk of introducing of an infection during extended treatments. The antimicrobial coating preferably is comprised of silver ions impregnated into a hydrophilic carrier. Alternatively the silver ions are implanted onto the surface of the device 10 by ion beam deposition. The antimicrobial coating may also be an antiseptic or disinfectant such as chlorhexadiene, benzyl chloride or other suitable biocompatible antimicrobial materials impregnated into hydrophilic coatings. Antimicrobial coatings such as those provided by Spire, AST, Algon, Surfacine, Ion Fusion, or Bacterin International would be suitable. Alternatively a cuff member covered with the antimicrobial

coating may be provided on the elongated shaft of the delivery device 10 at the point where the device 10 enters the patient's skin.

[0028] The balloon 11 may also be provided with radiopaque material to facilitate detection during CT, X-ray or fluoroscopic imaging. Such imaging allows the physician or other staff to detect the size and shape of the balloon and whether the balloon is properly located at the desired location. Preferably, the exterior surface of an inner layer of the balloon is coated at least in part with radiopaque material. One suitable method for coating the surface of the layer is to mix a polymer, preferably essentially the same polymer of the layer, with a solvent such as tetrahydrofuran and a radiopaque agent such as a powdered metallic material, e.g. titanium, gold, platinum and the like, or other suitable radiopaque materials. The mixture is applied to the exterior surface of an inner balloon layer and the solvent is allowed to evaporate, leaving the radiopaque material and the polymer bonded to the balloon layer. The multiple layers of the balloon are then secured to the catheter shaft.

[0029] The device 10 may be used to treat a body cavity of a patient, e.g. a biopsy or lumpectomy site within a patient's breast, in the manner described in the previously referred to co-pending applications. Usually the adapter 13 on the proximal end of the catheter device extends out of the patient during the procedure when the balloon is inflated. The catheter shaft 11 is preferably flexible enough along a length thereof, so that once the balloon is inflated to its turgid condition, the catheter shaft can be folded or coiled and placed under the patient's skin before the exterior opening of the treatment passageway to the treatment site is closed. At the end of the treatment time, e.g. 5-10 days, the exterior opening can be reopened and the catheter removed from the patient. See for example the discussion thereof in previously discussed co-pending application Serial No. 11/357,274.

[0030] Radiation balloon catheters for breast implantation generally are about 6 to about 12 inches (15.2-30.5 cm) in length, typically about 10.6 inch (27 cm). The shaft diameter is about 0.1 to about 0.5 inch (2.5-12.7 mm), preferably about 0.2 to about 0.4 inch (5.1-10.2 mm), typically 0.32 inch (8 mm). The individual radiation lumens are about 0.02 to about 0.15 inch (0.5-3.8 mm), preferably about 0.04 to about 0.1 inch (1-1.5 mm). The balloons are designed for inflated configurations about 0.5 to about 4 inches (1.3-10.2 cm), typically about 1 to about 3 inches (2.5-7.5 cm) in transverse dimensions, e.g. diameters.

[0031] While particular forms of the invention have been illustrated and described herein, it will be apparent that various modifications and improvements can be made to the invention. To the extent not previously described, the various elements of the catheter device may be made from conventional materials used in similar devices. Moreover, individual features of embodiments of the invention may be shown in some drawings and not in others, but those skilled in the art will recognize that individual features of one embodiment of the invention can be combined with any or all the features of another embodiment. Accordingly, it is not intended that the invention be limited to the specific embodiments illustrated. It is therefore intended that this invention be defined by the scope of the appended claims as broadly as the prior art will permit.

[0032] Terms such as "element", "member", "component", "device", "means", "manufacture", "portion", "section", "steps" and words of similar import when used herein shall not be construed as invoking the provisions of 35 U.S.C. §112(6) unless the following claims expressly use the terms "means for" or "step for" followed by a particular function without reference to a specific structure or action. All patents and

all patent applications referred to above are hereby incorporated by reference in their entirety.

WHAT IS CLAIMED IS:

1. A catheter device for irradiating tissue surrounding a body site within a patient, comprising:

a. an elongated shaft which has a distal portion configured to be deployed within the body site;

b. a treatment location at the distal portion having or configured to receive a radiation source to irradiate tissue at least in part surrounding the body site; and

c. an inflatable balloon surrounding the treatment location with a wall thereof having at least two layers.

2. The device of claim 1 wherein the polymeric material of at least one layer of the inflatable balloon is at or near the elastic limit thereof when the inflatable member is inflated to a turgid condition.

3. The device of claim 2 wherein the inflatable balloon has a predetermined size and shape when in the turgid condition.

4. The device of claim 1 wherein the inflatable balloon has a volume expansion of less than 200% when inflated to a turgid condition.

5. The device of claim 1 wherein the inflatable balloon has a volume expansion of less than 175% when inflated to a turgid condition.

6. The device of claim 4 wherein the inflatable balloon has a volume expansion of about 50% to about 150% when inflated to a turgid condition.

7. The device of claim 1 wherein the inflatable balloon has an expansion of at least about 25% when inflated to a turgid condition.

8. The device of claim 1 wherein the inflatable balloon has radiopaque

material between two layers thereof.

9. The device of claim 1 wherein the layers of the balloon are about 0.0003 to about 0.006 inch thick.

10. The device of claim 9 wherein the layers of the balloon are about 0.001 to about 0.002 inch thick.

11. The device of claim 1 wherein total thickness of the multilayered balloon wall is about 0.0006 to about 0.012 inch thick.

12. The device of claim 11 wherein the total thickness of the multilayered balloon wall is about 0.002 to about 0.004 inch.

13. The device of claim 1 wherein at least one tubular member is provided within the treatment location which is configured to receive a radiation source within a lumen thereof and which is configured to locate the received radiation source at least 1 mm closer to a first portion of tissue surrounding the body cavity than to a second portion of tissue surrounding the body site.

14. The device of claim 1 wherein at least one of the tubular members is configured to locate the received radiation source at least 2 mm closer to a first portion of tissue surrounding the body site than a second portion of tissue surrounding the body site.

15. The device of claim 1 wherein the tubular member containing a radiation source is deflectable toward the first portion of tissue surrounding the body site so that the first lumen is closer to the first portion of tissue surrounding the body site than the second portion of tissue.

16. The device of claim 1 wherein a radiation shield is deployed within the distal shaft portion so as to absorb radiation directed at the second portion of tissue surrounding the body site.

17. The device of claim 1 wherein the distal shaft portion comprises a plurality of tubular members with an inner lumen extending through each of the plurality of tubular members configured to receive a radiation source.

18. The device of claim 17 wherein one or more of the tubular members are deflected or deflectable toward the first portion of tissue surrounding the body site to be closer thereto.

19. The device of claim 17 wherein a support member extends within the distal shaft portion to support one or more tubular members extending therein.

20. The device of claim 17 wherein the elongated shaft has a plurality of inner lumens which are configured to receive one or more radiation sources and which extend through the shaft to the tubular members at the treatment location.

21. The device of claim 1 wherein the distal shaft portion has at least one vacuum port and a vacuum lumen in fluid communication with the vacuum port.

22. The device of claim 21 wherein the vacuum lumen is configured to be in fluid communication with a vacuum source.

23. The device of claim 1 wherein the balloon is configured to partially fill the body site when in an inflated turgid condition.

24. The device of claim 1 wherein the balloon has an asymmetrical inflated turgid shape so that the radiation source is positioned closer to the first tissue portion than to the second tissue portion.

25. The device of claim 17 wherein at least one of the tubular members at the treatment location is off-set away from the longitudinal axis.

26. The device of claim 17 wherein the plurality of tubular members are evenly distributed about the longitudinal axis.

27. The device of claim 17 wherein at least one of the elongated tubular members has a multi-functional lumen.

28. The device of claim 27 wherein the multi-functional lumen has at least two functions selected from the group consisting of delivery of a vacuum, delivery of a radiation source and delivery of inflation fluid.

29. The device of claim 19 wherein the support member has a centrally disposed lumen which is axially aligned with the tubular members.

30. A device for irradiating a body cavity within a patient, comprising:

a. an elongated shaft having a proximal portion, a distal portion and a treatment location within the distal portion of the shaft, at least one inflation lumen extending to the distal portion and at least one radiation delivery lumen extending to the treatment location;

b. an inflatable balloon on the distal portion of the shaft which surrounds the treatment location, which has at least two separate layers, which has a volumetric expansion of less than 200% when inflated to a turgid condition that at least in part fills the body cavity; and

c. a radiation source within or configured to be deployed within the radiation delivery lumen in the treatment location.

31. The device of claim 30 wherein at least one layer of the inflatable balloon has a stress at or near the elastic limit thereof when the inflatable member is inflated to a turgid condition.

32. The device of claim 30 wherein the inflatable balloon has a predetermined size and shape when in the turgid condition.

33. The device of claim 30 wherein the inflatable balloon has a volumetric expansion of less than 175% when inflated to a turgid condition.

34. The device of claim 30 wherein the inflatable balloon has a volumetric expansion of about 50% to about 150% when inflated to a turgid condition.

35. The device of claim 30 wherein the inflatable balloon has an expansion of at least about 25% when inflated to a turgid condition.

36. The device of claim 30 wherein the layers of the balloon have a thickness of about 0.0003 to about 0.006 inch in an un-inflated condition.

37. The device of claim 30 wherein the layers of the balloon are about 0.001 to about 0.002 inch thick.

38. The device of claim 30 wherein total thickness of the multilayered balloon wall is about 0.0006 to about 0.012 inch thick.

39. The device of claim 30 wherein the total thickness of the multilayered balloon wall is about 0.002 to about 0.004 inch.

40. The device of claim 30 wherein the inflatable balloon comprises radiopaque material.

41. The device of claim 40 wherein the material of at least one of the balloon layers has radiopaque material incorporated therein.

42. The device of claim 40 wherein at least one of the balloon layers has a surface coated with radiopaque material.

43. The device of claim 40 wherein radiopaque material is disposed between balloon layers.