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(54) SYSTEM AND METHOD FOR HIGH PRESSURE DELIVERY OF RADIOACTIVE MATERIAL FOR CANCER THERAPY

(71) Applicant: **BOSTON SCIENTIFIC SCIMED, INC.**, Maple Grove, MN (US)

(72) Inventors: **Timothy A. OSTROOT**, Cokato, MN (US); **Summan RAHMAN**, Murphy, TX (US); **Shannon MCGILL**, Friendswood, TX (US); **Marin SCHIFFMAN**, Lemont, IL (US); **Aiden FLANAGAN**, Kilcolgan (IE); **Yuping WEI**, Woodbury, MN (US)

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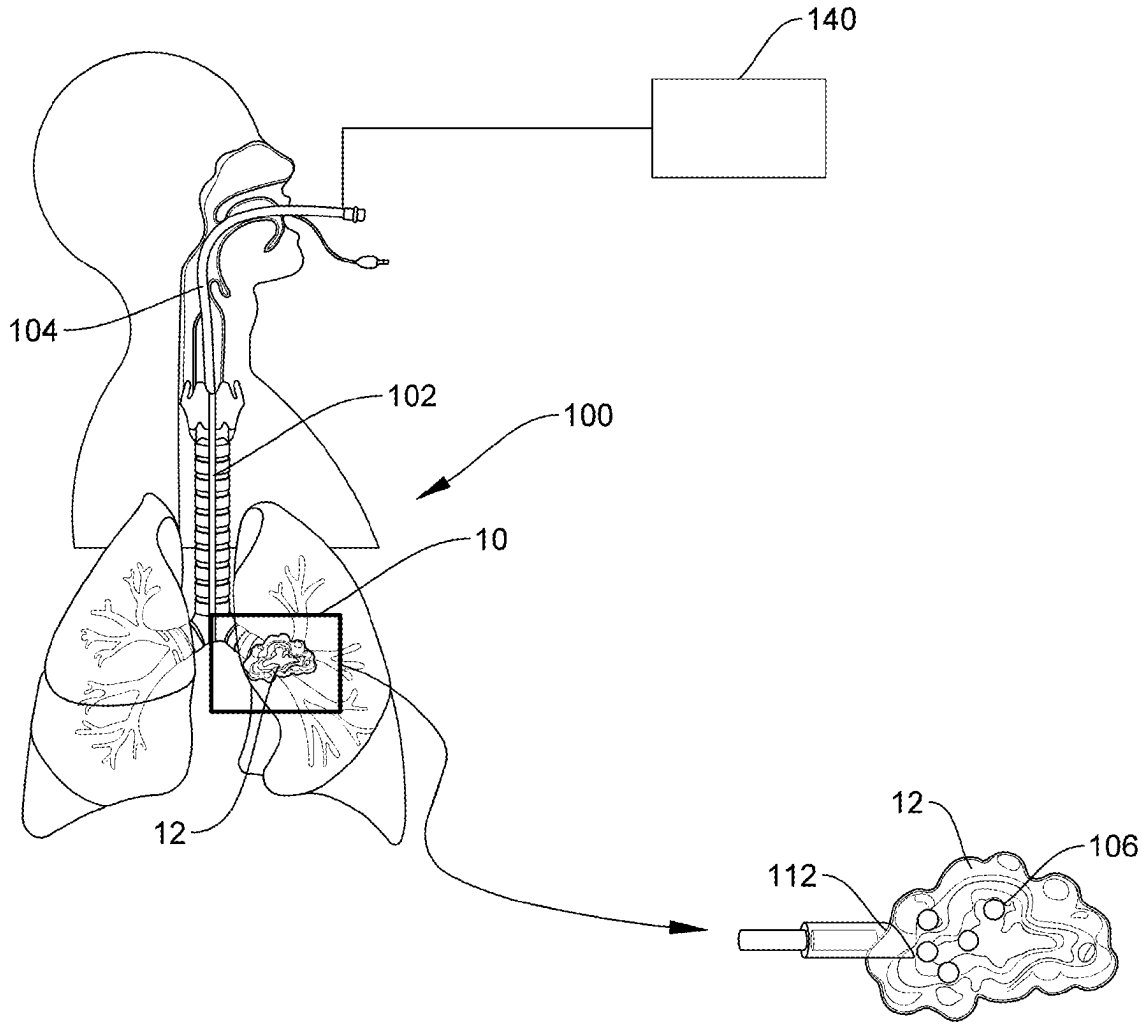
(57) **ABSTRACT**

A system includes a device, a radioactive deliverable and a pressure source. The device includes a shaft and a needle received therein. The needle extends longitudinally from a proximal end to a distal end and is slidably received within a channel of the shaft. The needle is movable between an insertion configuration, in which a tip at the distal end thereof is housed within the channel of the shaft, and a piercing configuration, in which the needle is moved distally relative to the shaft so that the tip extends distally from the channel of the shaft to pierce a target tumor. The deliverable is inserted into a channel of the needle. The source is coupled to the proximal end of the needle to apply a pressure through the channel of the needle that is sufficient to inject the deliverable through the channel and into the tumor.



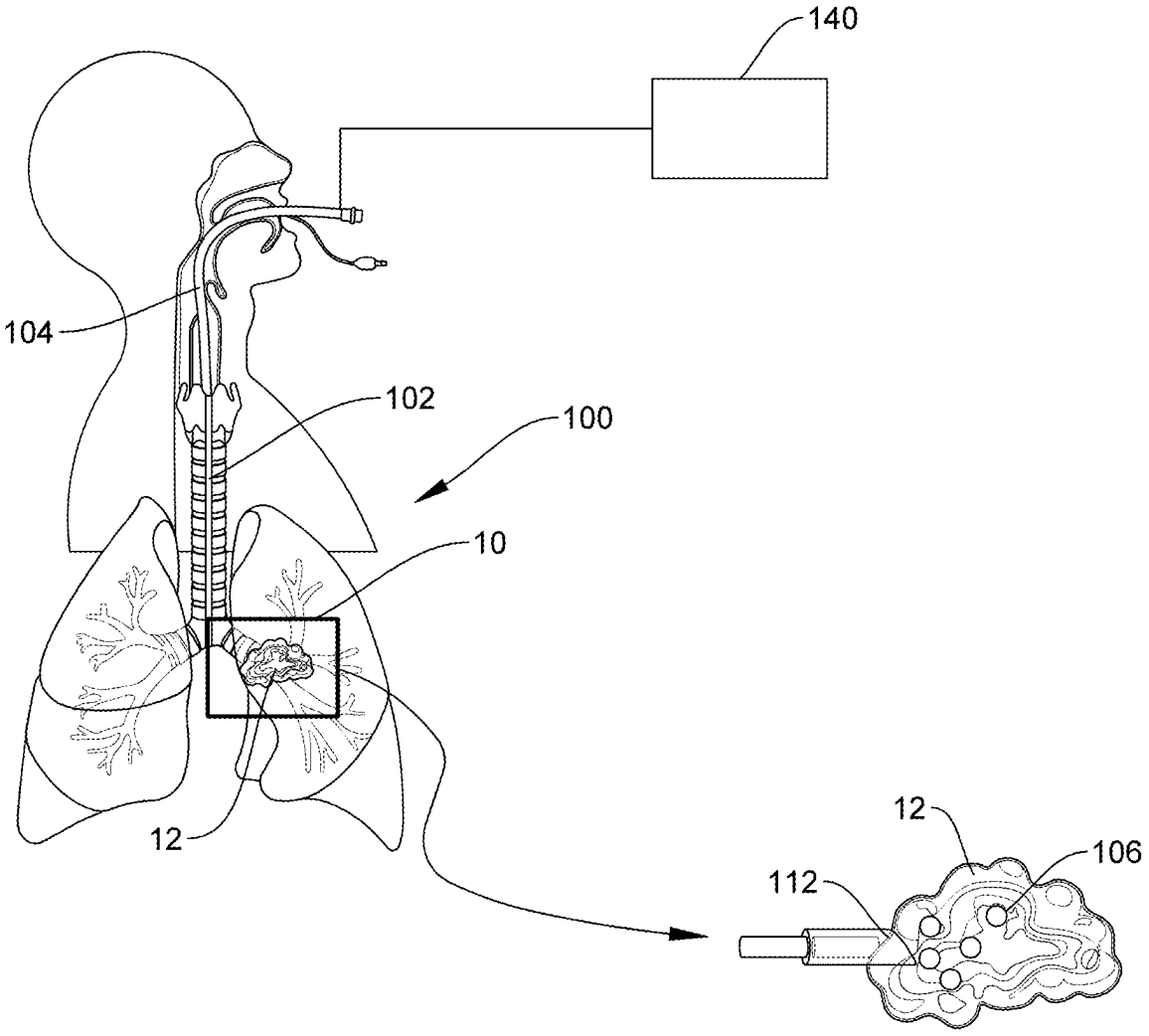


FIG. 1

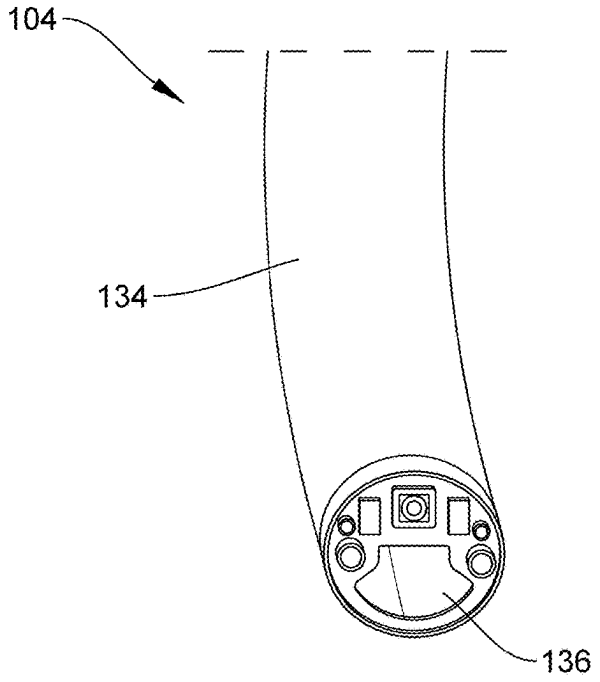


FIG. 2

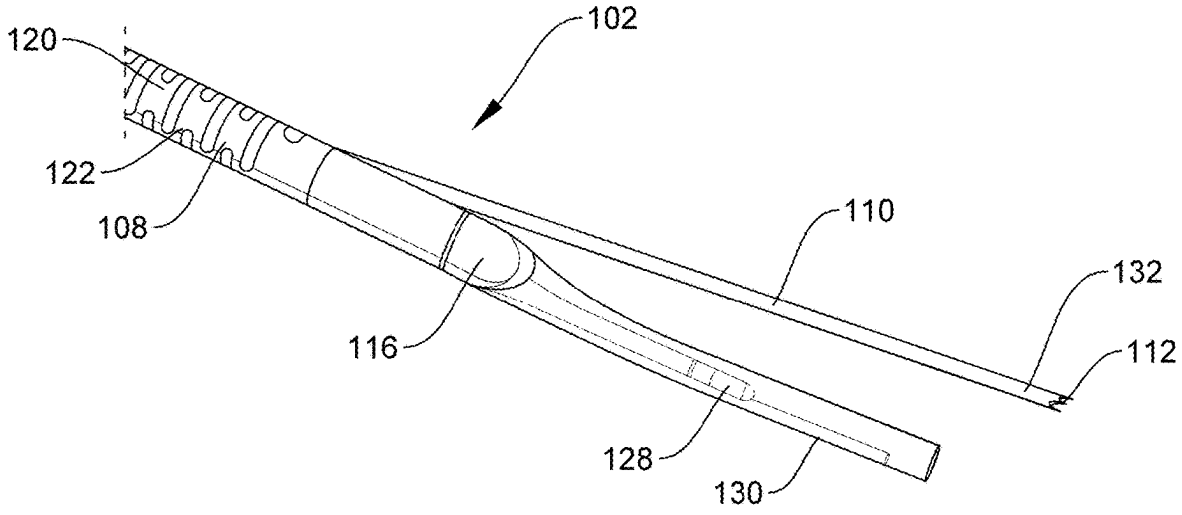


FIG. 3

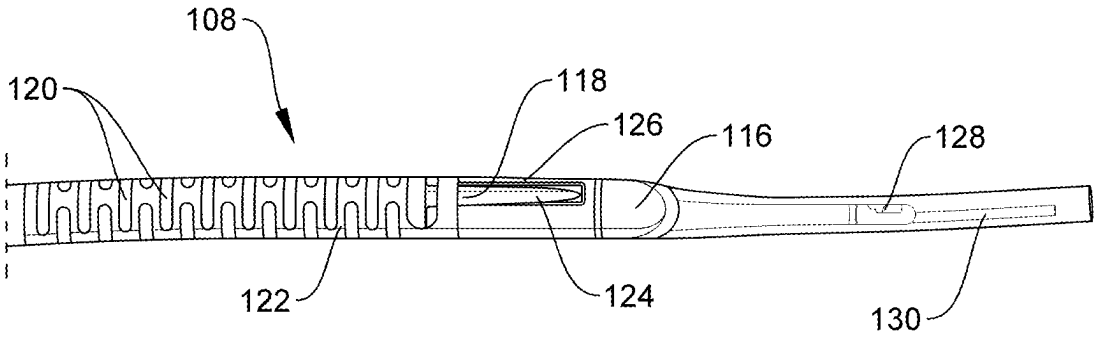


FIG. 4

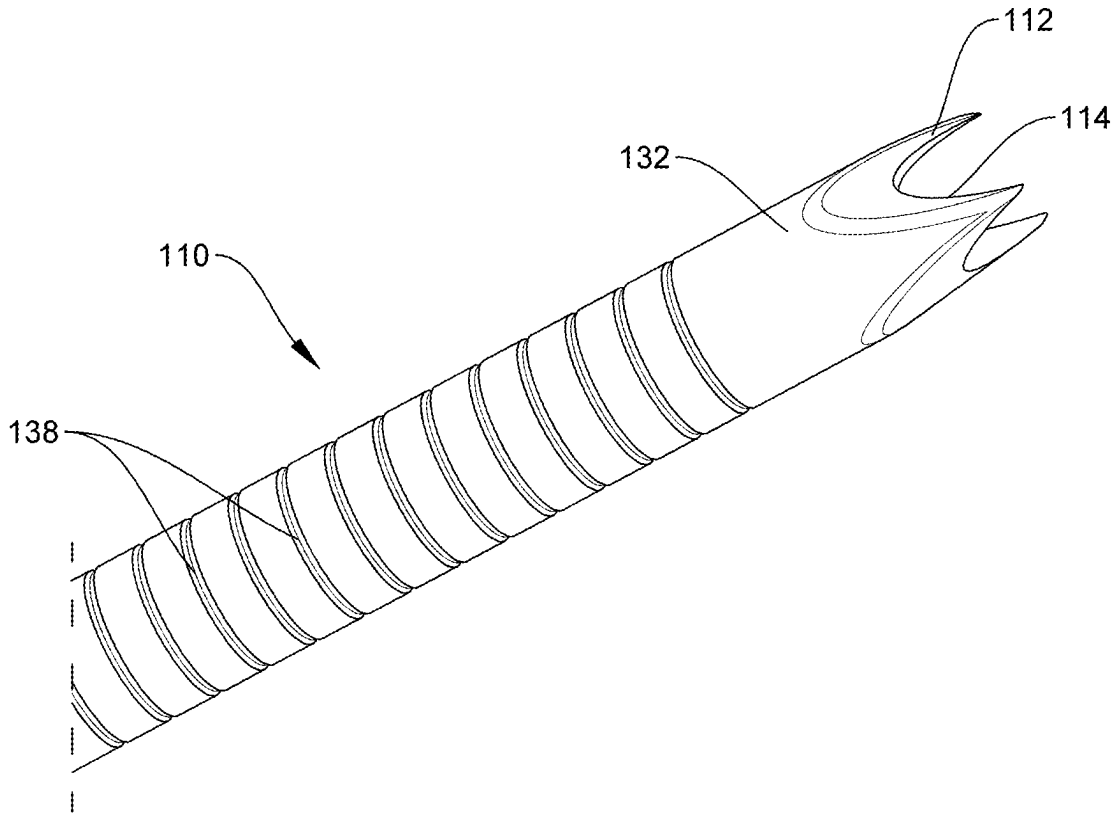


FIG. 5

SYSTEM AND METHOD FOR HIGH PRESSURE DELIVERY OF RADIOACTIVE MATERIAL FOR CANCER THERAPY

PRIORITY CLAIM

[0001] The present disclosure claims priority to U.S. Provisional Patent Application Ser. No. 63/551,732 filed Feb. 9, 2024; the disclosure of which is incorporated herewith by reference.

FIELD

[0002] The present disclosure relates to a system and method for cancer treatment and, in particular, relates to a system and method for endoscopic delivery of radioactive material for targeted cancer therapy.

BACKGROUND

[0003] Non-small cell lung cancer accounts for approximately 85% of lung cancers and is the most common cause of cancer deaths. It arises from epithelial cells lining the airway and usually begins in the bronchi lining. Existing therapies may include, for example, surgery, resection, radiation therapy, chemotherapy, targeted drug therapy, and immunotherapy. In some cases, however, targeted treatment of non-small lung cancer may be difficult to achieve due to its location in deeper anatomies (e.g., smaller branches of the bronchial tree).

SUMMARY

[0004] The present disclosure relates to a system for tumor ablation. The system includes a needle device comprising a shaft and a needle received therein, the shaft extending longitudinally from a proximal end to a distal end and including a channel extending therethrough, the needle extending longitudinally from a proximal end to a distal end and configured to be slidably received within the channel of the shaft, the needle movable between an insertion configuration, in which a tip at the distal end thereof is housed within the channel of the shaft, and a piercing configuration, in which the needle is moved distally relative to the shaft so that the tip extends distally from the channel of the shaft to pierce a target tumor.

[0005] The system also includes a radioactive deliverable configured to be inserted into a channel of the needle. In addition, the system includes a pressure source configured to be coupled to the proximal end of the needle to apply a pressure through the channel of the needle that is sufficient to inject the radioactive deliverable through the channel and into the target tumor.

[0006] In an embodiment, the shaft includes echogenic features along an exterior surface of a distal portion of the shaft.

[0007] In an embodiment, the shaft includes an ultrasound transducer extending distally from the distal end thereof.

[0008] In an embodiment, the shaft includes a needle indicator extending from the distal end of the shaft and visible via the ultrasound transducer to visualize a position of the needle relative to the shaft.

[0009] In an embodiment, the pressure is selected to achieve one of a desired depth of injection, dispersion, and leakage prevention of the radioactive deliverable.

[0010] In an embodiment, the radioactive deliverable is one of a microsphere embedded with a radioactive substance, a viscous gel including a radioactive substance, and a bioresorbable plug including a radioactive substance.

[0011] In an embodiment, the needle includes echogenic features along a portion of a length thereof.

[0012] In an embodiment, the tip of the needle includes one of a taper and a sharpened edge.

[0013] In addition, the present disclosure relates to a system for tumor ablation. The system includes a delivery device including a flexible shaft that is sized, shaped, and configured to be inserted through a bodily passageway to a target area within a patient. The system also includes a needle device configured to be inserted through a working channel of the delivery device to a target tumor in the target area, the needle device including a shaft and a needle slidably received therein, the shaft extending longitudinally from a proximal end to a distal end and including a channel extending therethrough, the needle extending longitudinally from a proximal end to a distal end and configured to be slidably received within the channel of the shaft, the needle movable between an insertion configuration, in which a tip at the distal end thereof is housed within the channel of the shaft, and a piercing configuration, in which the needle is moved distally relative to the shaft so that the tip extends distally from the channel to pierce the target tumor

[0014] In addition, the system includes a radioactive deliverable insertable through a channel of needle so that when a pressure is applied through the channel of the needle, the radioactive deliverable is injected into the target tumor.

[0015] In an embodiment, the delivery device is a bronchoscope.

[0016] In an embodiment, the shaft includes an ultrasound transducer extending distally from the distal end thereof.

[0017] In an embodiment, the pressure is selected to achieve one of a desired depth of injection, dispersion, and leakage prevention of the radioactive deliverable.

[0018] In an embodiment, the radioactive deliverable is one of a microsphere embedded with a radioactive substance, a viscous gel including a radioactive substance, and a bioresorbable plug including a radioactive substance.

[0019] In an embodiment, one of the shaft and the needle includes echogenic features along a portion of a length thereof.

[0020] In an embodiment, the tip of the needle is one of tapered and sharpened.

[0021] In addition, the present disclosure relates to a method for treating tissue. The method includes inserting a flexible shaft of a delivery device to a target area within a lung; inserting a needle device through a working channel of the delivery device to a target tumor in the target area; moving the needle device from an insertion configuration, in which a tip of a needle of the needle device is received within a channel of the shaft, toward a piercing configuration, in which the needle is moved distally relative to the shaft so that the tip of the needle pierces the target tumor; and injecting a radioactive deliverable received within the channel of the shaft into the target tumor by applying a pressure through a channel of the needle.

[0022] In an embodiment, inserting the needle device to the target tumor includes navigating the needle device toward the target tumor via ultrasound guidance.

[0023] In an embodiment, the method further includes positioning the needle device in a desired position relative to the target tumor via a visualization of a needle indicator which indicates a position of the needle relative to the shaft.

[0024] In an embodiment, the pressure is selected to achieve one of a desired depth of injection, dispersion, and leakage prevention of the radioactive deliverable.

[0025] In an embodiment, the radioactive deliverable is one of a microsphere embedded with a radioactive substance, a viscous gel including a radioactive substance, and a bioresorbable plug including a radioactive substance.

BRIEF DESCRIPTION

[0026] FIG. **1** shows a partially cross-sectional schematic side view of a system according to an exemplary embodiment of the present disclosure;

[0027] FIG. **2** shows a perspective view of a distal portion of a delivery device according to the exemplary system of FIG. **1**;

[0028] FIG. **3** shows a side view of a distal portion of a needle device according to the exemplary system of FIG. **1**;

[0029] FIG. **4** shows a side view of a distal portion of a shaft of the needle device according to FIG. **3**; and

[0030] FIG. **5** shows an enlarged side view of a distal portion of a needle of the needle device according to FIG. **3**.

DETAILED DESCRIPTION

[0031] The present disclosure may be further understood with reference to the following description and the appended drawings, wherein like elements are referred to with the same reference numerals. The present disclosure relates to a system and method for cancer treatment and, in particular, relates to a system and method for high pressure delivery of radioactive materials to a target area. Exemplary embodiments of the present disclosure comprise a needle device configured to be inserted to the target area to provide high pressure delivery of radioactive material into a tumor. The needle may be inserted to the target area via a delivery device such as, for example, a working channel of a scope device.

[0032] Although exemplary embodiments of the present disclosure are described as utilized for the treatment of non-small cell lung cancers, it will be understood by those of skill in the art that the systems and methods of the present disclosure may be similarly utilized for the treatment of various cancers that may benefit from targeted, high-pressure delivery of radioactive materials thereinto. It will also be understood by those of skill in the art that the terms proximal and distal, as used herein, are intended to refer to a direction toward (proximal) and away from (distal) a user of the device.

[0033] As shown in FIGS. **1-5**, a system **100** for providing high pressure delivery of a radioactive deliverable **106** to target tissue (e.g., a target tumor **12**) according to an exemplary embodiment comprises a needle device **102** configured to be inserted to a target area **10** via a delivery device **104** such as, for example, a bronchoscope or other scope device. Upon insertion of the delivery device **104** to the target area **10**, the needle device **102** is inserted through a working channel of the delivery device **104** and guided to the target tumor **12** under, for example, ultrasound guidance. The needle device **102** includes a shaft **108** and a needle **110** slidable within the shaft **108**.

[0034] The needle device **102** is configured to be moved distally out of the delivery device **104** and guided to the target tumor **12** via ultrasound guidance and/or guidance from a vision system of the delivery device. As shown in FIG. **1**, the needle **110** includes a tip **112** configured to pierce the target tumor **12** so that the radioactive deliverable **106** is injectable through a channel **114** of the needle **110** into the target tumor **12**, e.g., for tumor ablation. It will be understood by those of skill in the art that the radioactive deliverable **106** may provide targeted treatment of the target tumor **12** and/or may be used to provide pre-surgical intervention to reduce the size of the target tumor **12**.

[0035] In an exemplary embodiment, the delivery device **104** is configured to be inserted to a target area **10** within a patient's body (e.g., within a lung) and may include, for example, a bronchoscope or other scope device (e.g., endoscope). As shown in FIG. **2**, the delivery device **104** may include a flexible shaft **134** sized, shaped and configured to be passed through, for example, the nose or mouth, to the lung (e.g., via the trachea) and includes a visualization system including, for example, optical fibers, to provide visualization to a user (e.g., physician) of the airways of the patient. The flexible shaft **134** may be sized, shaped and sufficiently flexible to be insertable through bronchial passageways within the lung and includes a working channel **136** via which the needle device **102** may be inserted to the target area **10**, as will be described in further detail below.

[0036] In an exemplary embodiment, the needle device **102** is configured to be inserted to the target area **10** via the working channel **136** of the delivery device **104**. Upon arrival at the target area **10**, the needle device **102** may be navigated to the target tumor **12** under ultrasound guidance as indicated above. The needle device **102** is sized, shaped, and configured to access distal bronchial passages and in one example, may have a 25 gauge. As described above and as shown in FIG. **3**, the needle device **102** includes the shaft **108** and the needle **110**.

[0037] As shown in FIGS. **3-4**, the shaft **108** extends longitudinally from a proximal end (not shown) that remains outside the patient's body to a distal end **116** and includes a channel **118** extending therethrough. In an exemplary embodiment, a distal portion of the channel **118** includes a ramped surface **124** configured so that a distal opening **126** of the channel **118** extends through a wall of the shaft **108**, proximally of the distal end **116** of the shaft **108**. In other words, as the needle **110** is slid distally along the channel **118**, the ramped surface **124** deflects the tip **112** of the needle **110** so that it moves out of the channel **118** with a portion of the needle **110** extending out of the shaft **108** angled with respect to a longitudinal axis of the shaft **108**.

[0038] The ramped surface **124** of this embodiment facilitates insertion of the needle **110** into peripherally extending nodules/tumors (i.e., into tissue that is lateral the insertion device when the insertion device is inserted into a body lumen). In another exemplary embodiment, the channel **118** extends longitudinally through the shaft **108**, from the proximal end to the distal end **116**, so that the channel **118** is substantially aligned with the longitudinal axis of the shaft **108** and, so that the longitudinal axis of a portion of the shaft **108** within a body lumen is substantially parallel to the longitudinal axis of the body lumen at this location. Thus, the deflection of the tip **112** of the needle **110** allows the needle **110** to penetrate luminal tissue adjacent to a side wall of the shaft **108**.

[0039] In an exemplary embodiment, the shaft **108** is formed of a metal material and is configured so that the shaft **108** is rotatable about the longitudinal axis thereof. In one example, the shaft **108** is formed of a braided metal material.

The shaft **108** of this embodiment includes echogenic features **120** along an exterior surface of at least a distal portion **122** thereof to enhance a signal from an ultrasound imaging system to facilitate navigation of the needle device **102** to the target tumor **12**. The echogenic features **120** may include, for example, surface features such as a coating, dimples, grooves, or bumps on an exterior surface of a distal portion **122** of the shaft **108**.

[0040] In an exemplary embodiment, the needle device **102** further includes an ultrasound transducer **128** extending distally from the distal end **116** of the shaft **108**. The ultrasound transducer **128** is configured to provide visualization as the shaft **108** is moved distally from the delivery device **104** toward the target tumor **12**. In an exemplary embodiment, the ultrasound transducer **128** is a radial transducer configured to enhance visualization of peripheral tumors and/or nodules. In another exemplary embodiment, the ultrasound transducer **128** may include a forward-looking transducer.

[0041] The needle device **102** may further include an additional element such as, for example, a needle indicator **130** configured to facilitate a desired position of the needle device **102** relative to the target tumor **12** and/or to navigate the needle device **102** to the target tumor **12**. According to an exemplary embodiment, the needle indicator **130** is configured to provide visualization of a relative position of the needle **110** relative to the shaft **108**. The needle indicator **130** may be formed of a metal and may similarly extend distally from the distal end **116** of the shaft **108**. In an exemplary embodiment, the needle indicator **130** may extend along the ultrasound transducer **128**, along a side of a longitudinal axis of the shaft **108** opposite the distal opening **126** of the shaft **108** from which the needle **110** extends. It will be understood by those of skill in the art, however, that the needle indicator **130** may have any of a variety of configurations so long as the needle indicator **130** is visible via the ultrasound transducer **128** to indicate a position of the needle **110** and/or a position of the distal opening **126** of the channel **118** relative to the shaft **108**. Thus, a user (e.g., physician) may visualize the position of the shaft **108** relative to the target tumor **12** to facilitate insertion of the needle **110** into the target tumor **12**, as desired, and indicating an orientation of the shaft **108** so that, if necessary, the shaft **108** may be rotated to aim the needle **110** toward the target tissue.

[0042] According to another exemplary embodiment, the needle indicator **130** may be configured as a separate guidewire that is advanceable and/or torqueable relative to, for example, the shaft **108** of the needle device **102** to aid in distal nodule navigation and targeting. It will be understood by those of skill in the art, however, that the needle indicator **130** may have any of a variety of configurations so long as the needle indicator **130** aids in the positioning/navigation of the needle device **102** relative to the target tumor **12**.

[0043] As shown in FIGS. **3** and **5**, the needle **110** extends longitudinally from a proximal end (not shown) to a distal end **132** and includes the channel **114** extending therethrough from the proximal end to the distal end **132**. The needle **110** is sized, shaped sufficiently flexible and otherwise configured to be slidable through the channel **118** of the shaft **108**. In an insertion configuration, the needle **110** is housed within the shaft **108** such that the distal end **132** of the needle **110** is housed within the channel **118** of the shaft **108**—i.e., the distal end **132** does not extend distally of the distal opening **126** of the channel **114** of the shaft **108**. In a piercing configuration, the distal end **132** of the needle **110** is extended distally relative to the shaft **108** until the distal end **132** extends distally out of the distal opening **126** of the channel **118** to pierce the target tumor **12**.

[0044] The distal end **132** includes the tip **112**, which is configured to facilitate piercing of the target tumor **12**. In an exemplary embodiment, the tip **112** may, for example, be tapered and/or include a sharpened edge. It will be understood by those of skill in the art that the tapering of the tip **112** may facilitate both a piercing of the target tumor **12** and, upon injection of the radioactive deliverable **106** into the target tumor **12**, retention of the radioactive deliverable **106** within the target tumor **12**. According to one example, the tip **112** may include a tube trocar. It will be understood by those of skill in the art, however, that the tip **112** may have any of a variety of configurations so long as the tip **112** is configured to puncture the target tumor **12**, as described in further detail below.

[0045] The needle **110** of this embodiment is configured to extend from the distal end **116** of the shaft **108** and/or the distal opening **126** of the channel **118** of the shaft **108** via a desired length, corresponding, for example, to a desired depth of insertion of the tip **112** into the target tumor **12**. It will be understood by those of skill in the art that this desired length may be adjusted based on a location, size and/or shape of the target tumor **12**. In an exemplary embodiment, the needle **110** may similarly include echogenic features **138** along a portion thereof to increase visibility under ultrasound guidance. In one example, the echogenic features **138** may extend along a portion of the needle **110** which extends out of the shaft **108**.

[0046] The needle **110** of this embodiment is formed of a metal material and is configured to shield surrounding portions of tissue (i.e., non-targeted tissue) from the radiation supplied by the radioactive deliverable **106** received in the needle **110** and passed therethrough to the target tumor **12**. The metal material is also configured to withstand pressures required to deliver the radioactive material to the target tumor **12**. According to an exemplary embodiment, the needle **110** may further include a metal lure attachment at the proximal end thereof, via which the radioactive deliverable **106** may be received within the channel **114** of the needle **110**. As will be described in further detail below, the proximal end of the needle **110** is also configured to be connected to a pressure source **140** configured to provide pressurized delivery of the radioactive deliverable **106**.

[0047] The radioactive deliverable **106** may be in any of a variety of configurations so long as the radioactive material is configured to provide targeted radiation and is suitable for insertion to the target tumor **12** via the channel **114** of the needle **110**. In an exemplary embodiment, the radioactive deliverable **106** includes microspheres formed of, for example, glass or other suitable materials, which are embedded with a radioactive substance configured to provide targeted radioembolization. In another embodiment, the radioactive deliverable **106** includes a temporary and/or bioresorbable plug configured to be passed through the channel **114** of the needle **110**. In yet another embodiment, the radioactive deliverable **106** is configured as a gel or fluid having a viscosity appropriate permitting it to be passed through the channel via high pressure delivery. It will be understood by those of skill in the art that the radioactive

deliverable **106** is generally configured to provide a desired dosing tailored to the requirements of a specific patient.

[0048] In an exemplary embodiment, the radioactive deliverable **106** includes visualization markers configured to enhance tracking of the location at which the radioactive material has been injected into the tumor and/or to assess a dispersion of the radioactive deliverable **106** within the tumor. The visualization markers may include, for example, CT, Fluro fiduciaries, ultrasound additives, fluorescing markers, SPACE OAR gel type spacers. In another embodiment, the radioactive material has heating/cooling capabilities for controlling a viscosity of the radioactive deliverable **106** and a tissue take-up thereof.

[0049] As described above, the pressure source **140** is configured to be coupled to the needle **110** and may take any of a variety of configurations so long as the pressure source **140** is configured to provide pressure sufficient to inject the radioactive deliverable **106** through the needle **110** into the target tumor **12**. In an exemplary embodiment, the pressure source **140** includes a pressure cartridge such as, for example, a multi-injection capable CO2 cartridge/syringe or a nitrogen cartridge. The pressure source **140** may be actuated via any of a number of actuators including, for example, an electronic pushbutton trigger.

[0050] As would be understood by those skilled in the art, the pressure source **140** is configured to provide a pressure sufficient to overcome a PSI drop due to, for example, a length and diameter of the needle **110** and/or a viscosity or form (e.g., solid) of the radioactive deliverable **106**. As would also be understood by those skilled in the art, the delivery pressure is generally selected such that the radioactive deliverable **106** to be sufficient to inject the material to a desired depth within the target tumor **12** and/or to achieve a desired dispersion thereof. The delivery pressure may also be selected so as to prevent leakage of the radioactive material from the target tumor **12**. In an exemplary embodiment, the pressure source **140** is shielded (e.g., formed of metal) to withstand any deleterious effects of the radioactive material of the radioactive deliverable **106**. In an embodiment, the pressure source **140** is pre-irradiated and includes the radioactive deliverable **106**.

[0051] According to a further exemplary embodiment, to prevent leakage of the radioactive deliverable **106** from the target tumor **12**, the injection of the radioactive deliverable **106** into the target tumor **12** is followed up with, for example, a collagen plug, SpaceOAR, a viscous gel, or an expanding occlusion foam.

[0052] According to an exemplary method for providing targeted cancer treatment utilizing the system **100**, the delivery device **104** (e.g., bronchoscope) is inserted into a target area **10** in a passageway of the lung via, for example, a nose or mouth of the patient. Upon reaching the target area **10**, the needle device **102** may be guided to the target tumor **12**, which is positioned further distally in the passageway, under ultrasound guidance. The shaft **108** of the needle device **102** according to an exemplary embodiment includes echogenic features **120** so that the needle device **102** is visible via ultrasound as it is moved toward the target tumor **12**. As described above, the passageway and/or target tumor **12** may be visualized via the ultrasound transducer **128** at the distal end **116** of the shaft **108** as the needle device **102** is moved distally theretoward. The distal end **116** of the shaft **108** may be positioned adjacent and/or in contact with the target tumor **12**.

[0053] Upon reaching the target tumor **12**, the needle device **102** may be rotated, as necessary, so that the needle **110** is aimed toward the target tumor **12**, as desired (i.e., so that a path of the needle **110** extends into the target tumor **12** when the tip **112** is moved distally out of the shaft **108**). As described above, a relative position of the needle **110** relative to the shaft **108** may be visualized via the needle indicator **130**. Once the shaft **108** has been positioned relative to the target tumor **12**, as desired, the needle **110** is moved distally relative to the shaft **108** so that the tip **112** pierces the target tumor **12** and is inserted thereinto.

[0054] Upon insertion of the tip **112** into the target tumor **12**, the radioactive deliverable **106** are inserted into the channel **114** of the needle **110** via, for example, a radioactive shielding luer attachment at the proximal end of the needle **110**. Pressure may then be provided to the channel **114** via the pressure source **140** (e.g., pressure cartridge) connected to the proximal end of the needle **110** to inject the radioactive deliverable **106** into the target tumor **12**. As described above, the pressure source **140** is generally configured to apply pressure sufficiently high to overcome PSI drops along the length of the channel **114** and/or caused via the radioactive deliverable **106** so that a desired depth of injection, dispersion and/or retention of the radioactive deliverable **106** in the target tumor **12** is achieved. In a further embodiment, upon injection of the radioactive deliverable **106**, the target tumor **12** may be plugged via, for example, collagen, foam, viscous gel, etc., to prevent leakage of the radioactive deliverable therefrom.

[0055] Although the exemplary embodiments specifically show and describe treatment of non-small cell cancer and/or pulmonary cancer treatment, the systems and methods described herein may be utilized to treat alternate locations within the body and/or utilized with alternate modalities. For example, the needle device **102** may be inserted through a desired passageway without the use of an endoscope. Such an alternate system may include, for example, a guide catheter and/or a steering guide system. In another embodiment, the system **100** may include additional features for providing combination therapy. In one example, the delivery device **104** may include a wire attachment for impedance sensing for tumor detection, for providing RF application, and/or to provide a thermal IRE for tumor ablation. In an exemplary embodiment, the RF and/or IRE may be used for tumor "priming" prior to or following injection of the radioactive deliverable **106** to enhance the efficacy of the radioactive deliverable **106**.

[0056] In addition, although the exemplary embodiments specifically describe the injection of radioactive deliverables **106**, the system **100** may similarly be utilized for injection of a variety of different deliverable configurations. For example, deliverables may include pharmaceutical, drug, therapeutic, gene, virus, cell, protein, immunotherapy treatments.

[0057] It will be apparent to those skilled in the art that various modifications may be made in the present disclosure, without departing from the scope of the disclosure. Furthermore, those skilled in the art will understand that the features of any of the various embodiments may be combined in any manner that is not inconsistent with the description and/or the functionality of the embodiments.

1-15. (canceled)

16. A system for tumor ablation, comprising:

a needle device comprising a shaft and a needle received therein, the shaft extending longitudinally from a proximal end to a distal end and including a channel extending therethrough, the needle extending longitudinally from a proximal end to a distal end and configured to be slidably received within the channel of the shaft, the needle movable between an insertion configuration, in which a tip at the distal end thereof is housed within the channel of the shaft, and a piercing configuration, in which the needle is moved distally relative to the shaft so that the tip extends distally from the channel of the shaft to pierce a target tumor;

a radioactive deliverable configured to be inserted into a channel of the needle; and

a pressure source configured to be coupled to the proximal end of the needle to apply a pressure through the channel of the needle that is sufficient to inject the radioactive deliverable through the channel and into the target tumor.

17. The system of claim **16**, wherein the shaft includes echogenic features along an exterior surface of a distal portion of the shaft.

18. The system of claim **16**, wherein the shaft includes an ultrasound transducer extending distally from the distal end thereof.

19. The system of claim **18**, wherein the shaft includes a needle indicator extending from the distal end of the shaft and visible via the ultrasound transducer to visualize a position of the needle relative to the shaft.

20. The system of claim **16**, wherein the pressure is selected to achieve one of a desired depth of injection, dispersion, and leakage prevention of the radioactive deliverable.

21. The system of claim **16**, wherein the radioactive deliverable is one of a microsphere embedded with a radioactive substance, a viscous gel including a radioactive substance, and a bioresorbable plug including a radioactive substance.

22. The system of claim **16**, wherein the needle includes echogenic features along a portion of a length thereof.

23. The system of claim **16**, wherein the tip of the needle includes one of a taper and a sharpened edge.

24. A system for tumor ablation, comprising:

a delivery device including a flexible shaft that is sized, shaped, and configured to be inserted through a bodily passageway to a target area within a patient;

a needle device configured to be inserted through a working channel of the delivery device to a target tumor in the target area, the needle device including a shaft and a needle slidably received therein, the shaft extending longitudinally from a proximal end to a distal end and including a channel extending therethrough, the needle extending longitudinally from a proximal end to a distal end and configured to be slidably received within the channel of the shaft, the needle movable between an insertion configuration, in which a tip at the distal end thereof is housed within the channel of the shaft, and a piercing configuration, in which the needle is moved distally relative to the shaft so that the tip extends distally from the channel to pierce the target tumor; and

a radioactive deliverable insertable through a channel of needle so that when a pressure is applied through the channel of the needle, the radioactive deliverable is injected into the target tumor.

25. The system of claim **24**, wherein the delivery device is a bronchoscope.

26. The system of claim **24**, wherein the shaft includes an ultrasound transducer extending distally from the distal end thereof.

27. The system of claim **24**, wherein the pressure is selected to achieve one of a desired depth of injection, dispersion, and leakage prevention of the radioactive deliverable.

28. The system of claim **24**, wherein the radioactive deliverable is one of a microsphere embedded with a radioactive substance, a viscous gel including a radioactive substance, and a bioresorbable plug including a radioactive substance.

29. The system of claim **24**, wherein one of the shaft and the needle includes echogenic features along a portion of a length thereof.

30. The system of claim **24**, wherein the tip of the needle is one of tapered and sharpened.

31. A method for treating tissue, comprising:

inserting a flexible shaft of a delivery device to a target area within a lung;

inserting a needle device through a working channel of the delivery device to a target tumor in the target area;

moving the needle device from an insertion configuration, in which a tip of a needle of the needle device is received within a channel of the shaft, toward a piercing configuration, in which the needle is moved distally relative to the shaft so that the tip of the needle pierces the target tumor; and

injecting a radioactive deliverable received within the channel of the shaft into the target tumor by applying a pressure through a channel of the needle.

32. The method of claim **31**, wherein inserting the needle device to the target tumor includes navigating the needle device toward the target tumor via ultrasound guidance.

33. The method of claim **31**, further comprising positioning the needle device in a desired position relative to the target tumor via a visualization of a needle indicator which indicates a position of the needle relative to the shaft.

34. The method of claim **31**, wherein the pressure is selected to achieve one of a desired depth of injection, dispersion, and leakage prevention of the radioactive deliverable.

35. The method of claim **31**, wherein the radioactive deliverable is one of a microsphere embedded with a radioactive substance, a viscous gel including a radioactive substance, and a bioresorbable plug including a radioactive substance.

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