US 20180036084A1

(19) United States

(12) Patent Application Publication

KRIMSKY

(10) Pub. No.: US 2018/0036084 A1

(43) Pub. Date: Feb. 8, 2018

(54) SYSTEM AND METHOD OF USING AN ENDOSCOPIC CATHETER AS A PORT IN LAPAROSCOPIC SURGERY

(71) Applicant: **COVIDIEN LP**, MANSFIELD, MA (US)

(72) Inventor: **WILLIAM S. KRIMSKY**, FOREST HILL, MD (US)

(21) Appl. No.: **15/661,237**

(22) Filed: **Jul. 27, 2017**

Related U.S. Application Data

(60) Provisional application No. 62/369,986, filed on Aug. 2, 2016.

Publication Classification

(51) **Int. Cl.**

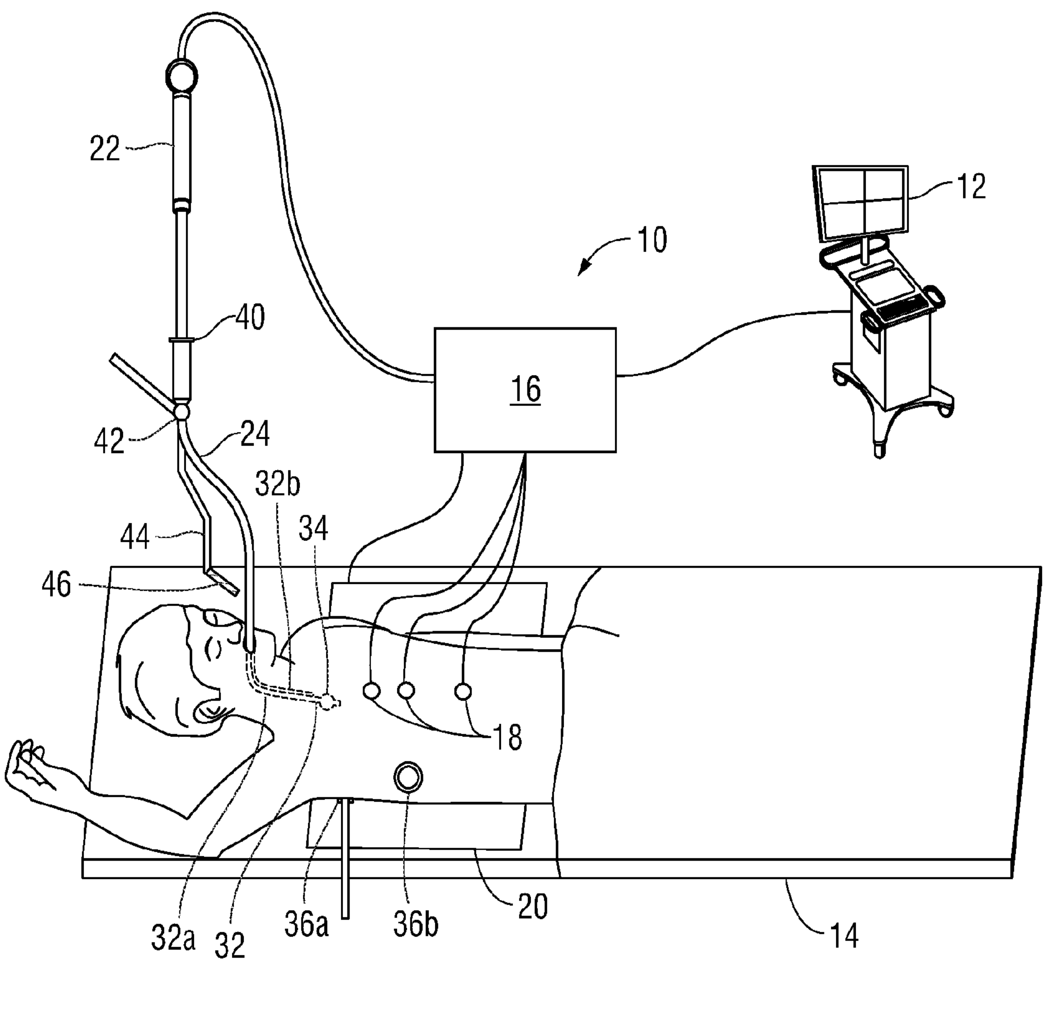
A61B 34/20	(2006.01)
A61B 34/10	(2006.01)
A61B 1/018	(2006.01)
A61B 1/267	(2006.01)
A61B 17/34	(2006.01)
A61B 1/00	(2006.01)

(52) **U.S. Cl.**

CPC ***A61B 34/20*** (2016.02); ***A61B 17/3423*** (2013.01); ***A61B 1/00087*** (2013.01); ***A61B 1/00154*** (2013.01); ***A61B 1/018*** (2013.01); ***A61B 1/267*** (2013.01); ***A61B 34/10*** (2016.02); *A61B 2034/2051* (2016.02); *A61B 2034/107* (2016.02)

(57) **ABSTRACT**

A surgical system including an endoscopic navigation catheter, at least one laparoscopic access port, a laparoscopic tool, and an endoscopic tool. The endoscopic navigation catheter is configured for navigation of a luminal network to an area of interest. The at least one laparoscopic access port is placed adjacent to the area of interest. The laparoscopic tool is configured for insertion through the at least one laparoscopic access port, and the endoscopic tool is configured for insertion through the endoscopic navigation catheter. The laparoscopic tool and endoscopic tool enable a combined laparoscopic and endoscopic approach to the area of interest.



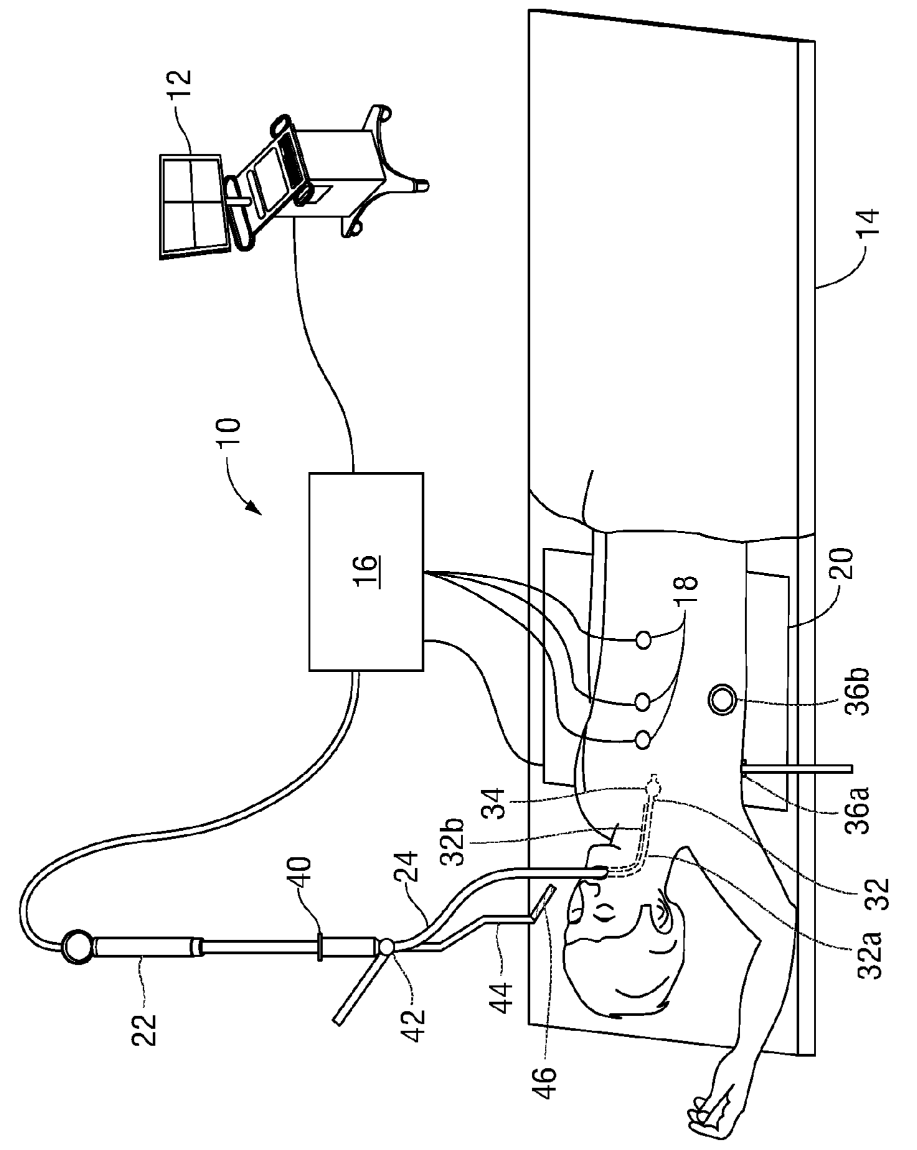
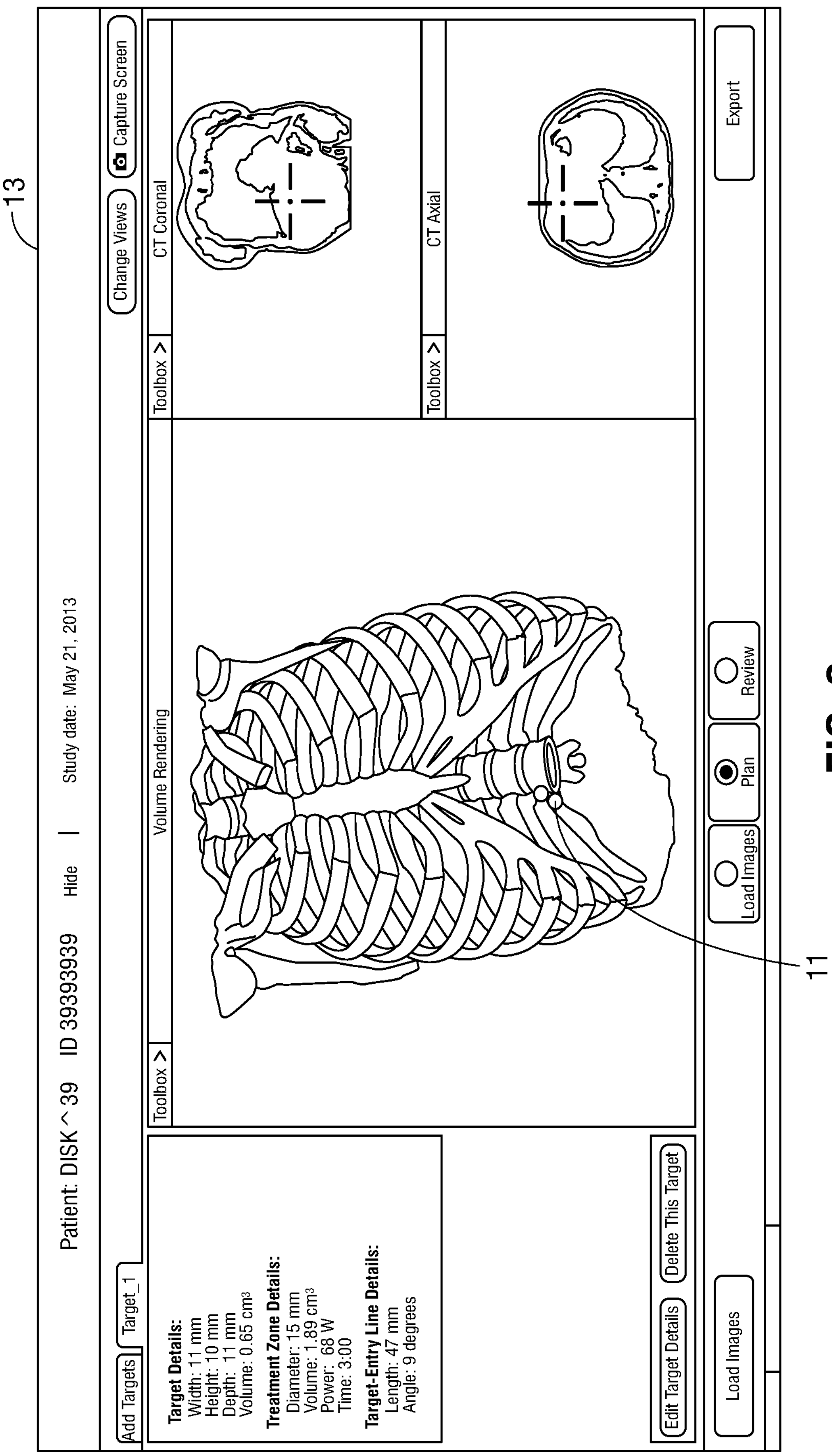


FIG. 1


13
Patient: DISK^39 ID 39393939 Hide | Study date: May 21, 2013
Add Targets
Target_1
Change Views
Capture Screen
Target Details:
Width: 11 mm
Height: 10 mm
Depth: 11 mm
Volume: 0.65 cm3
Treatment Zone Details:
Diameter: 15 mm
Volume: 1.89 cm3
Power: 68 W
Time: 3:00
Target-Entry Line Details:
Length: 47 mm
Angle: 9 degrees
Edit Target Details
Delete This Target
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CT Axial
Load Images
Load Images
Plan
Review
Export
11

FIG. 2

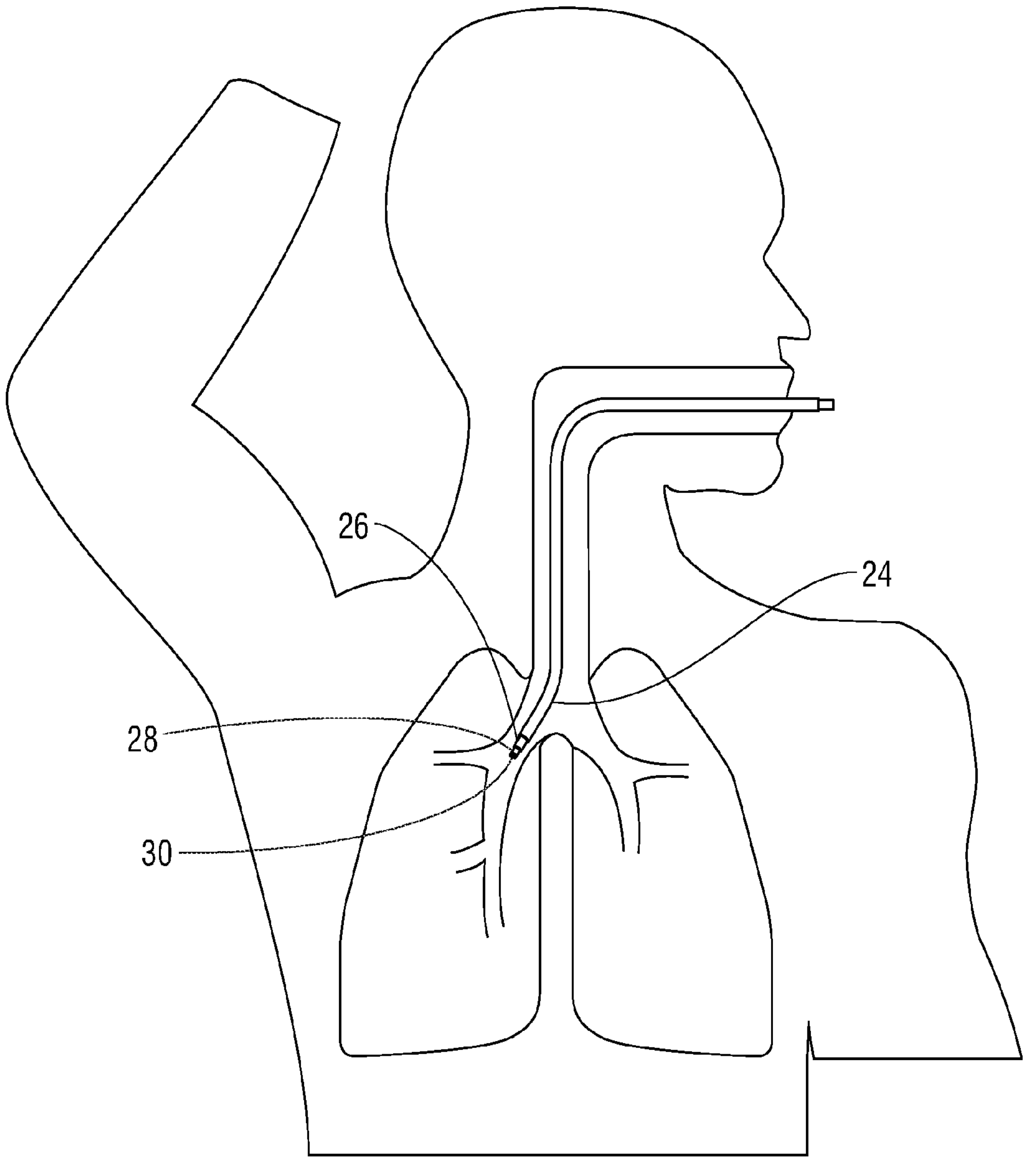

FIG. 3

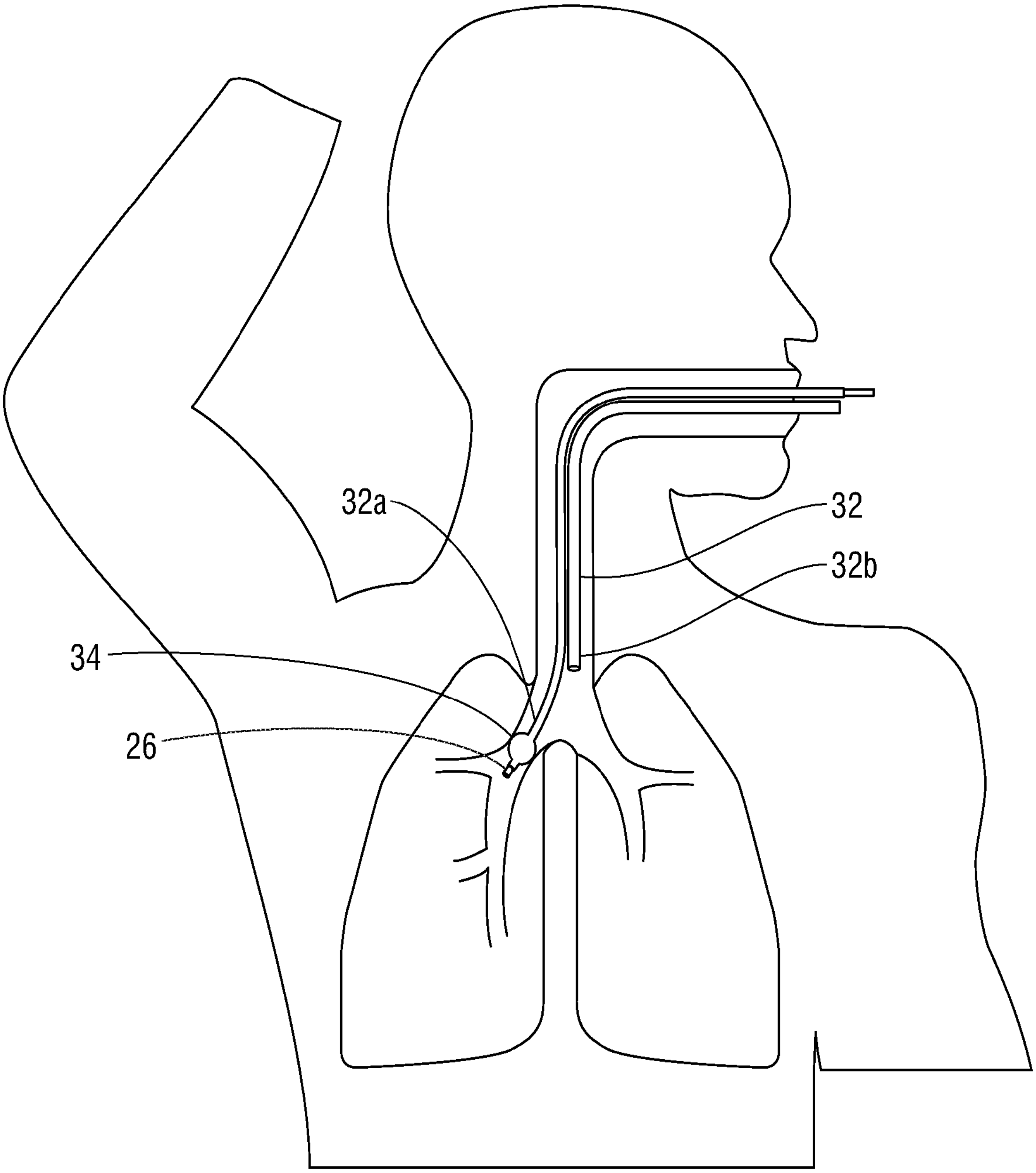

FIG. 4

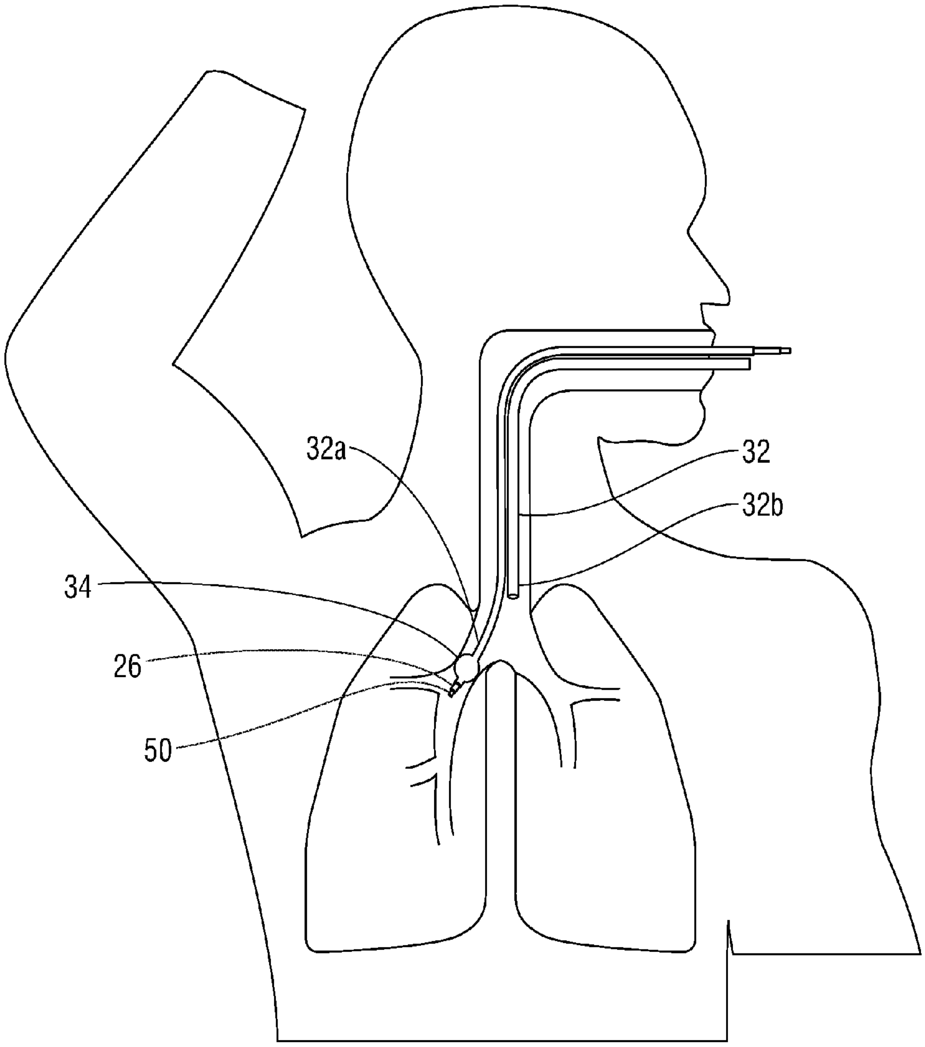

FIG. 5

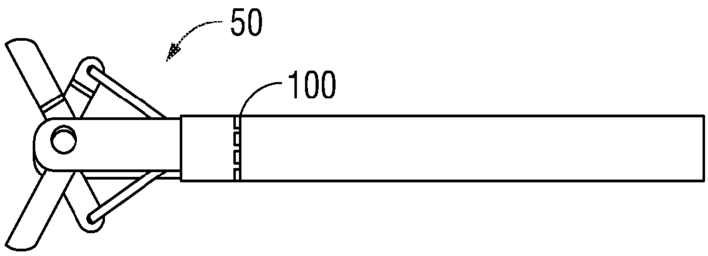

FIG. 6A

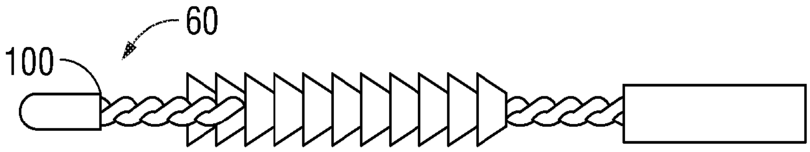

FIG. 6B

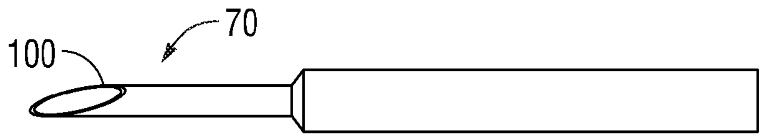

FIG. 6C

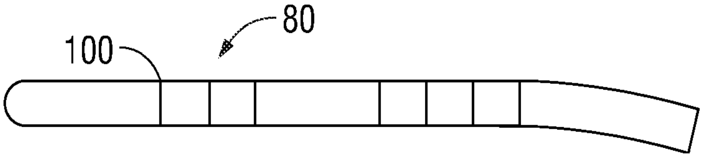

FIG. 6D

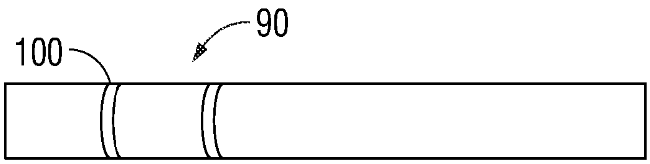

FIG. 6E

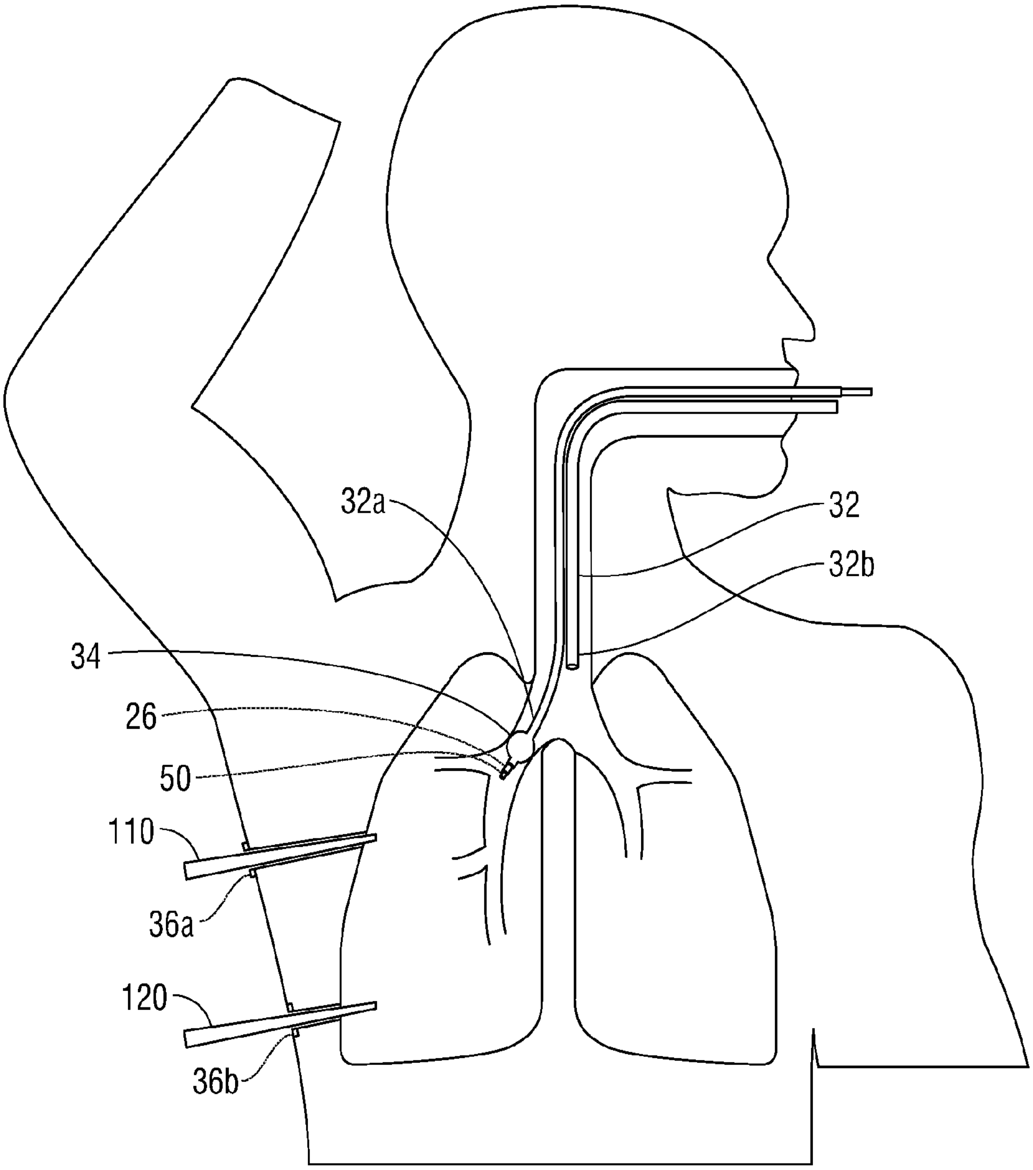

FIG. 7

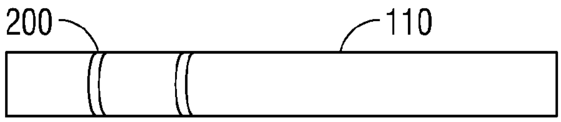

FIG. 8A

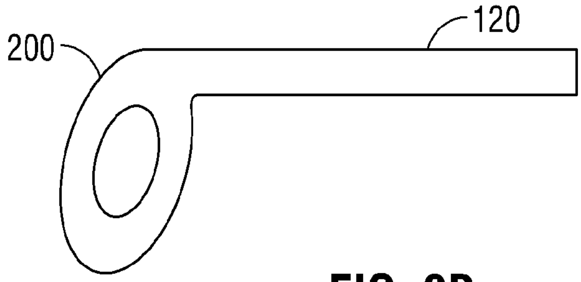

FIG. 8B

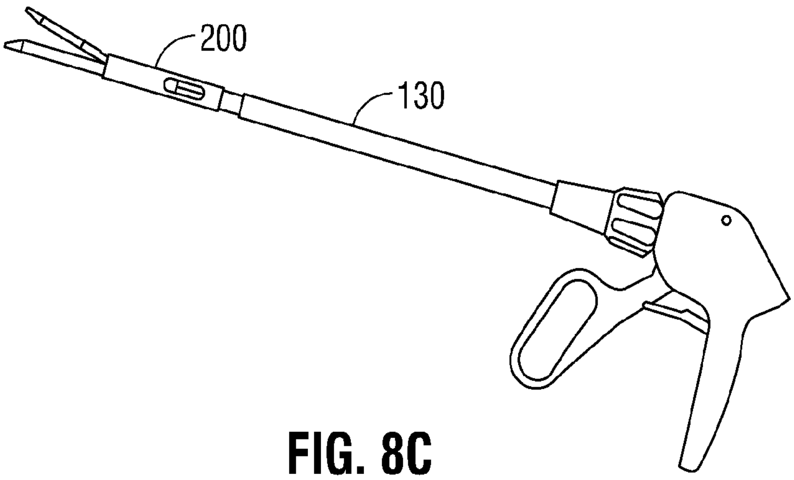

FIG. 8C

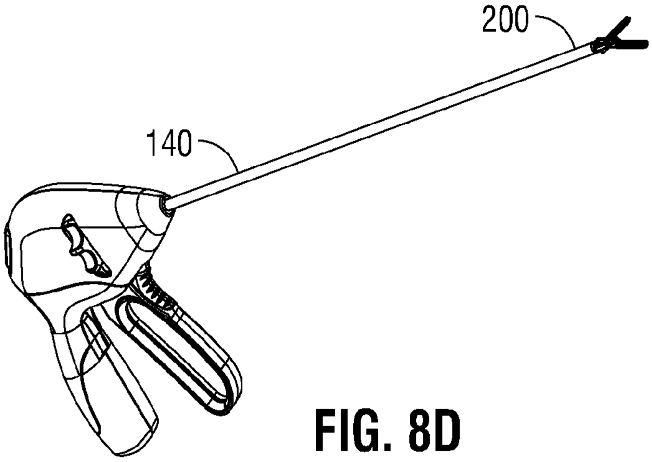

FIG. 8D

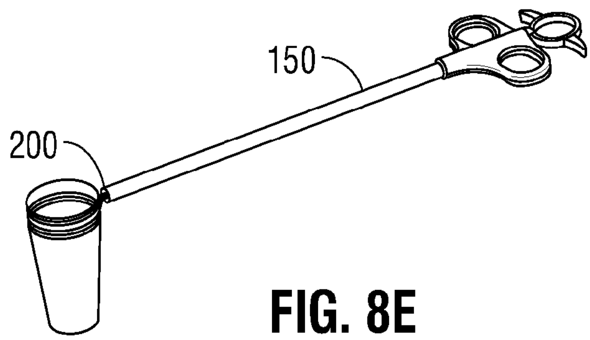

FIG. 8E

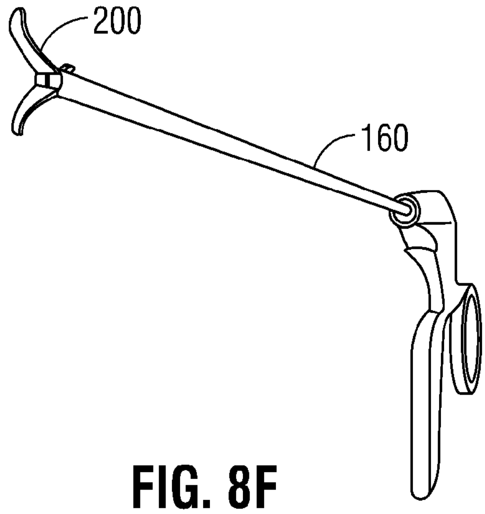

FIG. 8F

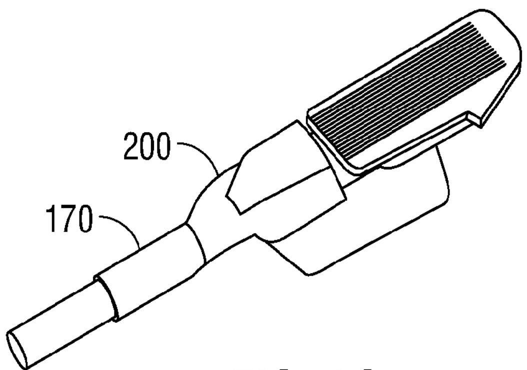

FIG. 8G

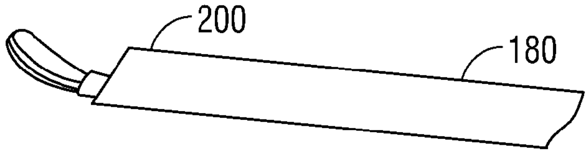

FIG. 8H

SYSTEM AND METHOD OF USING AN ENDOSCOPIC CATHETER AS A PORT IN LAPAROSCOPIC SURGERY

CROSS REFERENCE TO RELATED APPLICATION

[0001] The present application claims the benefit of and priority to U.S. Provisional Application Ser. No. 62/369,986, filed on Aug. 2, 2016 the entire contents of which are incorporated herein by reference.

BACKGROUND

Technical Field

[0002] The present disclosure relates to surgical systems, and more particularly, to systems and methods of performing combined endoscopic and laparoscopic surgery.

Description of Related Art

[0003] It is a daily occurrence for people to enter a medical facility in order to be diagnosed or treated by a clinician for a multitude of different medical conditions. Paramount to proper treatment and diagnosis in some instances is the clinician's ability to target and sufficiently access an area of interest. Additionally, in most circumstances, clinicians strive to minimize the invasiveness of the medical procedure. This goal of minimal invasiveness limits a clinician's options in accessing the area of interest, and thus medical procedures and medical tools have been developed accordingly. Common methods for a minimally invasive treatment are surgeries performed using one or more access ports enabling the insertion of tools (e.g., graspers and ligation tools) as well as optics enabling the clinician to view the area being treated. Access ports come in a variety of styles and mechanisms using bladed, bladeless, and blunt obturator type trocars. Access ports often have at least one cannula enabling the insertion of tools and optics therethrough. The trocars are inserted into the cannula and the combination is inserted through a small opening or incision on the patient. Once placed, the trocar is removed from the cannula leaving the cannula available for the insertion of tools. For a given application, the trocar and cannulas may be formed of stainless steel, plastics, and a combination of the two.

[0004] One specialty access port that is often used for "single port" surgeries are marketed by Medtronic under the name SILS™ Ports. SILS™ Ports are surgically inserted in the umbilicus of the patient and are formed of an elastomeric material. In one example, three cannulas transcend the port, enabling the insertion of three different tools through a single opening in the patient, which is in a location where it will leave little or no observable scarring. Indeed, "single port" approaches to laparoscopy are major advances because of the limited number of incisions and thus decreased "invasiveness" quotient which generally improves the outcome for the patient.

[0005] A well-known laparoscopic thoracic surgery is the video-assisted thoracoscopic surgery (VATS). Typically during a VATS, a patient is intubated with a double lumen endotracheal tube, with each lumen orientated towards a different lung. In this manner, a clinician may induce atelectasis in the lung to be treated or operated upon and provide proper ventilation to the untreated lung. Following the placement of the double lumen endotracheal tube, a clinician creates one or more incisions in the chest wall for the placement of one or more access ports. Commonly, a clinician will make at least three incisions. In some instances, the chest wall may be pierced by an insufflation needle prior to the incisions. The typical size of an incision ranges from about 2 centimeters to about 6 centimeters. The exact placement of each incision depends upon the area of the lung that the clinician is seeking to access, but generally each incision will be placed within a space between two of the patient's ribs and in a complementary position to one another. The clinician can then place the access ports in each incision relying on the trocar to enlarge or create an opening into which the cannula will rest at the completion of the insertion.

[0006] The clinician will generally select one of the access ports for the insertion of a surgical camera and will select the other access ports for the insertion of surgical tools. In some instances, the camera may be inserted into the trocar prior to insertion of surgical tools to enable the clinician to observe the insertion process. The use of each access port may be interchangeable throughout the procedure. The camera inserted through the selected port transmits images of inside the patient's thoracic cavity onto a video monitor, providing guidance for the clinician. Once the clinician has located the area of interest using the surgical camera, surgical tools are inserted and navigated through respective access ports to undertake the necessary treatments. After the treatment is completed, the camera and surgical tools are removed, the access ports are removed, and the incisions in the patient are closed. Due to the more fixed nature of the chest cavity, i.e. the fixed and non-compliant nature of the ribs, in comparison to the abdomen or pelvis, the appropriate geometry of the inserted surgical tools with respect to one another is even more critical.

[0007] Another minimally invasive approach is the use of endoscopy to reach a desired location within the body via a natural orifice (e.g., nose, mouth or anus). Though not exclusively, endoscopic approaches are often employed in diagnostic (e.g., biopsy) procedures, to eliminate the need for making an incision into a patient, though endoscopes can and are inserted into a patient via a small incision in certain instances.

[0008] A specific type of endoscopy, bronchoscopy, is used to examine a patient's lungs and airways. After the placement of a bronchoscope, the clinician may insert other surgical devices through the bronchoscope to diagnose or to provide treatment to the patient.

[0009] Though both laparoscopy and endoscopy are both quite useful approaches to minimizing injury to patients caused by the surgery or diagnostic procedure, both procedures place limits on the ability of the clinician to access all of the areas of interest. Accordingly, improvements are always desirable and sought after.

SUMMARY

[0010] In accordance with the present disclosure, a surgical system includes an endoscopic navigation catheter, at least one laparoscopic access port, a laparoscopic tool, and an endoscopic tool. The endoscopic navigation catheter is configured for navigation of a luminal network to an area of interest. The at least one laparoscopic access port is placed adjacent to the area of interest. The laparoscopic tool is configured for insertion through the at least one laparoscopic access port, and the endoscopic tool is configured for insertion through the endoscopic navigation catheter. The laparoscopic tool and endoscopic tool enable a combined laparoscopic and endoscopic approach to the area of interest. The endoscopic tool is selected from a group consisting of a biopsy forceps, a cytology brush, an aspirating needle, an ablation catheter, and a camera. The laparoscopic tool is selected from a group consisting of a camera, a lung forceps, a surgical stapler, a vessel sealer, a collection bag, a morcellator, an ablation catheter, and a cautery device.

[0011] In an aspect of the present disclosure, the surgical system includes a double lumen endotracheal tube. The endoscopic navigation catheter is configured for placement within one of the lumens of the double lumen endotracheal tube. The endoscopic navigation catheter is configured as an internal port allowing manipulation of the area of interest. The surgical system further includes an electromagnetic sensor operatively associated with the endoscopic navigation catheter. In one embodiment, the electromagnetic sensor is formed on a locatable guide. In another embodiment, the endoscopic tool includes an electromagnetic sensor positioned on a distal portion of the endoscopic tool, and the distal portion is trackable by a tracking system. In yet another embodiment, the laparoscopic tool includes an electromagnetic sensor positioned on a distal portion of the laparoscopic tool, and the distal portion is trackable by a tracking system.

[0012] In one method of the present disclosure, a double lumen endotracheal tube is placed within a luminal network of a patient. An endoscopic navigation catheter is inserted within a lumen of the double lumen endotracheal tube and an endoscopic tool is inserted therethrough. One or more laparoscopic access ports are implanted proximally to an area of interest. A laparoscopic tool is inserting through at least one of the laparoscopic access ports, and a combined laparoscopic and endoscopic procedure is performed to the area of interest.

[0013] The method may include reviewing image data of the patient to identify the area of interest and planning at least one pathway to identified area of interest. The method also includes performing a survey to collect location data of the luminal network, wherein the survey utilizes the endoscopic navigation catheter and an electromagnetic sensor operatively associated therewith. The electromagnetic sensor is embodied on a locatable guide. The registration of the image data occurs before placement of the double lumen endotracheal tube within the luminal network of the patient. Additionally, navigating the endoscopic navigation catheter through the lumen of the double lumen endotracheal tube to the area of interest and removing the locatable guide including the electromagnetic sensor from the endoscopic navigation catheter. The laparoscopic tool is also navigated to the area of interest. An endoscopic procedure is performed with the endoscopic tool and a laparoscopic procedure is performed with the laparoscopic tool.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] Various aspects and features of the present disclosure are described hereinbelow with reference to the drawings, wherein:

[0015] FIG. **1** is a perspective view of a surgical system provided in accordance with the present disclosure configured to perform a combined endoscopic and laparoscopic surgery;

[0016] FIG. **2** is an illustration of a user interface presenting a view of reviewing a three-dimensional multi-layered model in accordance with an embodiment of the present disclosure;

[0017] FIG. **3** is a front, cross-sectional, view of the lungs of a patient including a bronchoscope and a locatable guide including an electromagnetic sensor inserted therethrough;

[0018] FIG. **4** is a front, cross-sectional, view of the lungs of a patient including a double lumen endotracheal tube and an endoscopic navigation catheter inserted therethrough;

[0019] FIG. **5** is a front, cross-sectional, view of the lungs of a patient including a double lumen endotracheal tube, endoscopic navigation catheter, and an endoscopic tool;

[0020] FIGS. **6**A-**6**E are partial perspective views of the distal end portions of a plurality of different endoscopic tools in accordance with the present disclosure;

[0021] FIG. **7** is a front, cross-sectional, view of the lungs of a patient including a doubles lumen endotracheal tube, an endoscopic tool inserted into double lumen endotracheal tube, and laparoscopic tools inserted within external access ports; and

[0022] FIGS. **8**A-**8**H are partial perspective views of the distal end portions of a plurality of different laparoscopic tools in accordance with the present disclosure.

DETAILED DESCRIPTION

[0023] The present disclosure is directed to a system and method which reduces the number of access ports required to perform a procedure, and utilized the best aspects of laparoscopic and endoscopic approaches to provide the same or greater level of access as traditional laparoscopic approaches as well as utilizing unique aspects of the endoscopic approaches to enable further tissue presentation, marker placement, treatment options, and other benefits to a patient and a clinician.

[0024] Described above are a variety of access ports including SILS™ Ports and other devices for achieving minimally invasive access to the patient's abdominal and thoracic cavities. However, single port approaches have limitations and this is certainly true in the chest. Indeed thoracic surgeons have had limited enthusiasm for the single port approach given the geometries involved with operating on the lungs and the chest. The use of a single port approach is further limited by the increasing prevalence of robotic surgical approaches which in general utilize smaller individual incisions but which enhance the geometry challenges associated with fewer ports. In fact, in a traditional three access port VATS or thoracoscopy (VATS)—one port is for the camera and the other two are for various instruments—typically to grasp and hold. A forth port is sometimes added as well to stabilize the tissue so that one can grasp and hold it more easily.

[0025] The challenges aside, one significant benefit of limiting the number of access ports is a reduction in neuropraxias that occurs when the instruments place pressure on the nerves running along the inferior aspect of the ribs. Thus any reduction in the number of access ports being utilized to perform a procedure can have significant benefits to the patient and ease the challenges facing the clinician. Thus, by utilizing the functionality of an endoscope, or in the case of a VATS procedure, a bronchoscope, at least one and potentially more access ports can be eliminated from the procedure.

[0026] In the following description, surgical systems and methods of performing surgery will be described with reference to VATS and bronchoscopy procedures; however, a person skilled in the art would understand that these surgical systems and methods could be used for performing other types of surgeries employing both laparoscopic and endoscopic approaches.

[0027] The method of performing a combined laparoscopic and bronchoscopic VATS procedure is described herein to include four phases; however, each phase may be divided further to create an additional phase or phases may be combined. FIG. **1** depicts a surgical system **10** configured in part for reviewing image data to identify one or more areas of interest, and planning a pathway to an identified area of interest. This is referred to as a planning phase. Following successful planning, the surgical system **10** is employed in navigating an endoscopic navigation catheter to the area of interest, the navigation phase. Next, one or more endoscopic tools capable of performing a required task can be inserted into the endoscopic navigation catheter. This is the endoscopic phase. Finally or coincident with the endoscopic phase, the external placement of access ports adjacent the area of interest, and the use of laparoscopic tools through the access ports as well as the endoscopic tools placed through the endoscopic navigation catheter are utilized to treat a desired area of interest in the patient. This is the surgical phase. The planning, navigation, endoscopic, and surgical phases are all described in reference to an area of interest located within the thoracic cavity. However, all four phases may be performed when the area of interest is not located within the thoracic cavity.

[0028] Surgical system **10** generally includes an operating table **14** configured to support a patient "P"; a bronchoscope **24** configured for insertion through the patient's mouth "P's" and/or nose into the patient's "P's" airways; a double lumen endotracheal tube **32** configured for insertion through the patient's "P's" mouth into the patient's "P's" airways; a catheter guide assembly including a handle **22**, an endoscopic navigation catheter **26**, a locatable guide (LG) **28** including an electromagnetic sensor **30**; laparoscopic access ports **36***a*, **36***b* placed proximal to an area of interest; endoscopic tools **50-90** insertable through endoscopic navigation catheter **26**; laparoscopic tools **110-180** insertable through the laparoscopic access ports **36***a*, **36***b*; a work station **12** coupled to bronchoscope **24**, endoscopic tools **50-90**, and laparoscopic tools **110-180** for displaying video images received from bronchoscope **24**, endoscopic tools **50-90** and laparoscopic tools **110-180**, workstation **12** including software and/or hardware used to facilitate pathway planning and a user interface **13**, identification of area of interest, navigation to area of interest, digitally marking the area of interest, and tracking LG **28** including sensor **30**, endoscopic tools **50-90**, and laparoscopic tools **110-180**; a tracking system including a tracking module **16**, a plurality of reference sensors **18**, and a transmitter mat **20**; a support system including a clamping member **46**, an arm **44**, a coupling mechanism **42**, and a bronchoscope adapter **40**.

[0029] As shown in FIG. **1** and indicated above, endoscopic navigation catheter **26** and LG **28** including sensor **30** are part of catheter guide assembly. In practice, the endoscopic navigation catheter **26** is inserted into bronchoscope **24** and double lumen endotracheal tube **32** for access to a luminal network of the patient "P." Specifically, endoscopic navigation catheter **26** of catheter guide assembly may be inserted into a working channel of bronchoscope **24** or a channel of double lumen endotracheal tube **32** for navigation through the patient's "P's" luminal network. The LG **28** including sensor **30** is inserted into the endoscopic navigation catheter **26** and locked in position such that the sensor **30** extends a desired distance beyond the distal tip of the endoscopic navigation catheter **26**. The position and orientation (6 degrees-of-freedom) of the sensor **30** relative to the reference coordinate system, and the distal end of the endoscopic navigation catheter **26**, within an electromagnetic field can be derived.

[0030] With respect to planning phase and surgical system **10** depicted in FIG. **1**, a work station **12** utilizes a suitable imaged data for generating and viewing a three-dimensional model of the patient's "P's" airways, enables the identification of an area of interest on the three-dimensional model of the patient's "P's" airways (automatically, semi-automatically, or manually), and allows for determining a pathway through the patient's "P's" airways to the area of interest.

[0031] The planning phase may be performed in four separate sub-phases. In first sub-phase S**1**, suitable imaged data of patient "P" is generated using a suitable imaging device, such as MRI, ultrasound, CT scan, Positron Emission Tomography (PET), or the like, and the image data are stored within the memory coupled to work station **12**.

[0032] In second sub-phase S**2**, a clinician may review the image data and select an area of interest. A software application may be initiated to enable review of the image data. More specifically, the CT scans are processed and assembled into a three-dimensional CT volume, which is then utilized to generate a three-dimensional model of the patient's "P's" airways. Techniques for generating a three-dimensional model are described in U.S. Patent Application Publication No. 2015-0243042 to Averbuch et al. entitled "Region-Growing Algorithm," filed May 12, 2015, the entire content of which is incorporated by reference herein. A planning software application may be initiated to enable the selection of the area of interest. The clinician will evaluate the three-dimensional model of patient's "P's" airways and will select the area of interest. The three-dimensional model may be manipulated to facilitate identification of the area of interest on the three-dimensional model or two-dimensional images, and selection of a suitable pathway through the patient's "P's" airways to access the area of interest can be made.

[0033] In a third sub-phase S**3**, using planning software the clinician creates the pathway to the area of interest. Finally, in the fourth sub-phase S**4**, the clinician reviews and accepts the pathway plan and may save the pathway plan, three-dimensional model, and images derived therefrom to work station **12** for use during the navigation phase, endoscopic phase, and surgical phase. The clinician may repeat either or both the second and third phases S**2** and S**3** as needed to select additional areas of interest and/or create additional pathways. For example, the clinician may select additional areas of interest and may create a pathway to each area of interest. The clinician may also or alternatively create multiple pathways to the same area of interest. One such planning software is the ILOGIC® planning suite currently sold by Medtronic. Details of such planning software are described in commonly owned pending U.S. Patent Application Publication No. 2014-0270441 to Matt W.

Baker entitled "Pathway Planning System and Method," filed Mar. 15, 2013, the entire content of which is incorporated herein by reference.

[0034] In some embodiments, the planning phase may include an addition sub-phase **5**. In sub-phase **5**, the clinician may reference a three-dimensional multi-layered model **11** of the patient's "P's" anatomy to improve the pathways creating during sub-phase **3**. The three-dimensional model, generated during the sub-phase **2**, may provide the clinician with the three-dimensional multi-layered model **11** of the patient's "P's" anatomy including, for example, representation of the patient's "P's" skin, muscle, blood vessels, bones, airways, lungs, other internal organs, or other features of the patient's "P's" anatomy. The three-dimensional multi-layered model **11** allows the outer layer to be peeled back, removed, or adjusted to present a layer including the patient's "P's" ribs and layers including other anatomical features of the patient's "P's" internal anatomy to the clinician. The layers may be presented at different levels of opacity or transparency to allow the clinician to review the interior of the patient's "P's" torso relative to the area of interest. The three-dimensional multi-layered model **11** may be rotated by activating a user interface **13** including within work station **12** (FIG. **1**) to peel back, remove, or adjust the opacity and translucence of each layer of the three-dimensional multi-layered model **11** to provide the clinician with a visual representation of the planned pathway to the area of interest relative to surrounding critical structures within the patient's "P's" body. For example, the clinician may use the user interface **13** to select specific layers to be presented in the three-dimensional multi-layered model **11** or to adjust the opacity or translucence of each individual layer. The three-dimensional multi-layered model is described in U.S. Patent Application Publication No. 2016-0038248 to Bharadwaj et al. entitled "Treatment Procedure Planning System and Method," filed Aug. 10, 2015, the entire content of which is incorporated by reference herein.

[0035] With respect to the navigation phase, a six degrees-of-freedom electromagnetic tracking system, e.g., similar to those disclosed in U.S. Pat. Nos. 8,467,589 and 6,188,355, and published PCT Application Nos. WO 00/10456 and WO 01/67035, the entire content of each of which is incorporated herein by reference, or other suitable positioning measuring system, is utilized for performing registration of the images, the pathway, and navigation, although other configurations are also contemplated. As indicated above, tracking system includes a tracking module **16**, a plurality of reference sensors **18**, and a transmitter mat **20**. Tracking system is configured for use with LG **28** and particularly sensor **30**. As described above, LG **28** including sensor **30** is configured for insertion through endoscopic navigation catheter **26** into a patient's "P's" airways (either with or without bronchoscope **24** or double lumen endotracheal tube **32**) and are selectively lockable relative to one another via a locking mechanism.

[0036] Next, the navigation phase begins with patient "P" positioned on an operating table **14** which may be preceded by the administrating of general anesthesia. It is envisioned that patient "P" may be intubated immediately following sedation or intubated after registration, as detailed below. Depicted in FIG. **1**, bronchoscope **24** is inserted within patient's "P's" mouth, and as described above, endoscopic navigation catheter **26** and LG **28** including sensor **30** is inserted into the bronchoscope **24** for access to patient's "P's" airways.

[0037] As shown in FIG. **1**, transmitter mat **20** is positioned beneath patient "P." Transmitter mat **20** generates an electromagnetic field around at least a portion of the patient "P" within which the position of a plurality of reference sensors **18** and the sensor **30** can be determined with use of tracking module **16**. For a detailed description of the construction of exemplary transmitter mats, which may also be referred to as location boards, reference may be made to U.S. Patent Application Publication No. 2009-0284255 to Zur entitled "Magnetic Interference Detection System and Method," filed Apr. 2, 2009, the entire content of which is incorporated by reference herein. One or more reference sensors **18** are attached to the chest of the patient "P." The six degrees-of-freedom coordinates of reference sensors **18** are sent to work station **12** (which includes the appropriate software) where they are used to calculate patient's "P's" coordinate frame of reference. Registration, as detailed below, is generally performed to coordinate locations of the three-dimensional model and two-dimensional images from the planning phase with the patient's "P's" airways as observed through the bronchoscope **24**, and allow for the navigation phase to be undertaken with precise knowledge of the location of the sensor **30**, even in portions of the airways where the bronchoscope **24** cannot reach. Further details of such a registration technique and their implementation in luminal navigation can be found in U.S. Patent Application Publication No. 2011-0085720, to Ron Barak et al entitled "Automatic Registration Technique," filed May 14, 2010, the entire content of which is incorporated herein by reference, although other suitable techniques are also contemplated.

[0038] As seen in FIG. **3**, registration of the patient's "P's" location on the transmitter mat **20** is performed by inserting the bronchoscope **24** within the airways of patient "P" until a distal end of bronchoscope **24** can no longer traverse the airway (e.g., a dimension of bronchoscope **24** exceeds the airway), and inserting endoscopic navigation catheter **26** and LG **28** including sensor **30** within a working channel of bronchoscope **24** and moving LG **28** including sensor **30** through the airways of the patient "P." More specifically, data pertaining to locations of sensor **30**, while LG **28** is moving through the airways, is recorded using transmitter mat **20**, reference sensors **18**, and tracking module **16**. Rotation and translation of handle **22** of catheter guide assembly may facilitate maneuvering of a distal tip of LG **28**, and in particular embodiments the endoscopic navigation catheter **26** may be angled or curved to assist in maneuvering the distal tip of the LG **28** through the patient's "P's" airways. It is also contemplated that registration of the patient's "P's" location on the transmitter mat **20** may be performed without the bronchoscope **24** and the endoscopic navigation catheter **26** and LG **28** including sensor **30** can be directly inserted within the airways of patient "P." In some embodiments, the distal tip of LG **28** may be maneuvered by a steering mechanism (not shown). The steering mechanism may include one or more elongated tension elements, such as steering wires. The steering wires are arranged in a manner such that the steering wire, when actuated, causes deflection of the tip. The steering mechanism and techniques for navigating are described in U.S. Pat. No. 7,233,820 to Pinhas Gilboa entitled "Endoscope Structure and Techniques for Navigating to a Target in Branched Structure," filed Mar. 29, 2003, the entire content of which is incorporated by reference herein.

[0039] A shape resulting from this location data is compared to an interior geometry of passages of the three-dimensional model generated in the planning phase, and a location correlation between the shape and the three-dimensional model based on the comparison is determined, e.g., utilizing the software on work station **12**. In addition, the software identifies non-tissue space (e.g., air filled cavities) in the three-dimensional model. The software aligns, or registers, an image representing a location of sensor **30** with the three-dimensional model and two-dimensional images generated from the three-dimensional model, which are based on the recorded location data and an assumption that LG **28** including sensor **30** remains located in non-tissue space in the patient's "P's" airways. Alternatively, a manual registration technique may be employed by navigating the LG **28** including sensor **30** to pre-specified locations in the lungs of the patient "P," and manually correlating the images from the bronchoscope **24** to the model data of the three-dimensional model.

[0040] During registration, once the distal end of bronchoscope **24** is inserted to the farthest point possible within patient's "P's" airways, the bronchoscope **24** can be immobilized by the support system. As described above, the support system includes a clamping mechanism **46**, an arm **44**, a coupling mechanism **42**, and a bronchoscope adapter **40**. The support system may be utilized to secure bronchoscope **24** to a fixed structure within the operating theater. As depicted in FIG. **1**, clamping mechanism **46** may be secured to operating table **14** with arm **44** extending vertical therefrom. Coupling mechanism **42** may be coupled to the bronchoscope **24**, securing bronchoscope **24** to support system. Bronchoscope adapter **40** is connected to the bronchoscope **24** and support system, which allows endoscopic navigation catheter **26** to be inserted within bronchoscope **24** while bronchoscope **24** is being immobilized by support system.

[0041] Following registration of the patient "P" to the image data and pathway plan, the user interface **13** is displayed in the navigation software which sets the pathway that the clinician is to follow to reach the area of interest. One such navigation software is the ILOGIC® navigation suite currently sold by Medtronic. Details of such a navigation software are described in commonly owned and co-pending U.S. Patent Application Publication No. 2016-0000302, to Andrew E. Brown et al entitled "System and Method for Navigating within the Lung," filed Jun. 29, 2015, the entire content of which is incorporated herein by reference.

[0042] As depicted in FIG. **4**, upon completion of the registration, bronchoscope **24** may be removed from patient "P." In embodiments where patient "P" was not intubated prior to the placement of bronchoscope **24** or was intubated using a single lumen endotracheal tube, following the removal of bronchoscope **24**, patient "P" will be intubated using double lumen endotracheal tube **32**. The clinician will insert double lumen endotracheal tube **32** within the trachea of patient "P." It is envisioned that a clinician may insert bronchoscope **24** within one of lumens **32***a*, **32***b* of the double lumen endotracheal tube **32** for visual guidance in appropriately placing the double lumen endotracheal tube **32** within patient's "P's" airways. The images generated by bronchoscope **24** will be displayed by work station **12** or another suitable display may be configured to display images generated by bronchoscope **24**. After appropriate placement of double lumen endotracheal tube **32**, the bronchoscope **24** is removed. Endoscopic navigation catheter **26** including LG **28** with sensor **30** may then be placed within one of lumens **32***a*, **32***b* of the double lumen endotracheal tube **32** and navigated to the area of interest. The clinician may reference the three-dimensional images generated during the planning phase and the tracking system, which will track the movement of LG **28** including sensor **30**, for guidance in navigating to the area of interest.

[0043] The initial navigational phase is completed upon successfully navigating the endoscopic navigation catheter **26** proximate the area of interest. Navigation phase may be initiated again to navigate to other selected areas of interest and/or to follow additional pathways. For example, the clinician may select additional areas of interest and may create a pathway to the same target. The clinician may also or alternatively create multiple pathways to the same area of interest of the initial navigating phase.

[0044] Commencement of each endoscopic phase and surgical phase is interchangeable. In some instances, the endoscopic phase and surgical phase may be initiated simultaneously. Termination of each endoscopic phase and surgical phase is also interchangeable. In some embodiments, each the endoscopic phase and surgical phase may be terminated simultaneously. It is also envisioned that endoscopic phase and surgical phase may be performed simultaneously. In embodiments where the endoscopic phase and surgical phase are performed simultaneously, both phases are performed in a manner that preserves the aseptic surgical site. While performing the endoscopic phase and the surgical phase, the clinician may maneuver the working endoscopic tool **50-90** (FIGS. **6**A-**6**E) and the working laparoscopic tool **110-180** (FIGS. **8**A-**8**H) to avoid soiling and contamination of the aseptic surgical site. Additionally, the clinician may secure the working endoscopic tool **50-90** to the support system (FIG. **1**) so that the working endoscopic tool **50-90** is appropriately positioned to avoid contamination of the area of interest while performing the required tasked. By securing the working endoscopic tool **50-90** to the support system, the clinician may transition within the sterile surgical field without risking cross-contamination. Further, the aseptic surgical site is preserved by the formation of one contamination vector. The one contamination vector extends between a proximal end of endoscopic navigational catheter **26** and the access ports **36***a*, **36***b*.

[0045] Atelectasis may be induced in patient's "P's" lung to be treated during either the endoscopic phase or the surgical phase. A clinician may determine the appropriate phase when to induce atelectasis. In some embodiments, atelectasis may be induced by means of a balloon included within the double lumen endotracheal tube **32** (FIG. **1**) or other closure device disposed on an exterior surface thereof. In this manner, the double lumen endotracheal tube **32** including a balloon **34** would be employed to intubate the patient, as described above. Once the double lumen endotracheal tube **32** including a balloon **34** is appropriately placed, the balloon **34** may be inflated by means of a pump, syringe, or other suitable device in fluid communication therewith (not shown). As a result of the inflation, an exterior surface of the balloon **34** expands and compresses against the inner wall of the airway. In this manner, the treated lung is sealed off. It is contemplated that the air contained within the treated lung may be evacuated through a cannula defined through double lumen endotracheal tube **32** using any suitable means, such as a vacuum of the like (not shown), to induce atelectasis.

[0046] With respect to endoscopic phase depicted in FIG. **5**, endoscopic tools, such as those depicted in FIGS. **6**A-**6**E, including for example, biopsy forceps **50** (FIG. **6**A), a cytology brush **60** (FIG. **6**B), an aspirating needle **70** (FIG. **6**C), an ablation catheter **80** (FIG. **6**D), and a camera **90** (FIG. **6**E) are inserted into endoscopic navigation catheter **26** and navigated to the area of interest for treatment and/or diagnosis of patient "P." It is also contemplated that any other suitable endoscopic tool may be used for treatment and/or diagnosis of patient "P."

[0047] The endoscopic phase may begin with unlocking and removing the LG **28** including sensor **30** from endoscopic navigational catheter **26**. Removing LG **28** including sensor **30** leaves endoscopic navigation catheter **26** in place as a guide channel for guiding endoscopic tools **50-90** to the area of interest. Once endoscopic tools **50-90** are navigated proximately to the area of interest, endoscopic tools **50-90** may treat and/or diagnose the area of interest. Also, areas surrounding the area of interest may be treated by endoscopic tools **50-90**.

[0048] It is envisioned that LG **28** including sensor **30** may be eliminated and endoscopic tools **50-90** are utilized for navigation, similarly as detailed above with respect to LG **28** with sensor **30**. In this manner any of the above mentioned endoscopic tools **50-90** (FIGS. **6**A-**6**E), may include a sensor **100** that, in conjunction with tracking system (FIG. **1**), may be employed to enable tracking of a distal portion of endoscopic tools **50-90**, as the distal portion of endoscopic tools **50-90** is advanced through the patient "P's" airways, as detailed above. Thus, with additional reference to FIG. **1**, work station **12** or another suitable display may be configured to display the three-dimensional model and selected pathway, both of which were generated during the planning phase (as detailed above), along with the current location of the sensor **100** disposed in the distal portion of endoscopic tools **50-90** to facilitate navigation of the distal portion of endoscopic tools **50-90** to the area of interest and/or manipulation of the distal portion of endoscopic tools **50-90** relative to the area of interest.

[0049] With respect to surgical phase depicted in FIG. **7**, laparoscopic tools, such as those depicted in FIGS. **8**A-**8**H, including for example, a camera **110** (FIG. **8**A), a lung forceps **120** (FIG. **8**B), a surgical stapler **130** (FIG. **8**C), a vessel sealer **140** (FIG. **8**D), a collection bag **150** (FIG. **8**E), a morcellator **160** (FIG. **8**F), an ablation catheter **170** (FIG. **8**G), and a cautery device **180** (FIG. **8**H) may be inserted into laparoscopic access ports **36***a*, **36***b* that are proximal to the area of interest and navigated to the area of interest for treatment of patient "P." It is also contemplated that any other suitable laparoscopic tool may be used for treatment of patient "P."

[0050] Referencing work station **12** and three-dimensional images generated during the planning phase (as detailed above), the clinician will implant laparoscopic access ports **36***a*, **36***b* (FIG. **7**), as described above, approximately adjacent to the area of interest; however it is understood more or fewer ports may be implanted. Laparoscopic access ports **36***a*, **36***b* may be positioned to compliment endoscopic navigation catheter **26** and endoscopic tools **50-90**.

[0051] Laparoscopic tools **110-180** are designed for insertion within laparoscopic access ports **36***a*, **36***b*. Camera **110** may initially be inserted within one of access ports **36***a*, **36***b*, allowing an internal visual display. The images generated by camera **110** will be displayed by work station **12** or another suitable display may be configured to display images generated by camera **110**. A clinician may use the three-dimensional images generated during the planning phase and the images generated by camera **110** conjunctively for navigating the laparoscopic tools **110-180** to the area of interest and treating the area of interest. Additionally, it is envisioned that clinician may repeat sub-phase S2, S3 of planning phase to generate a pathway plan for inserting and navigating laparoscopic tools **110-180** to the area of interest.

[0052] Referring to FIGS. **8**A-**8**H, laparoscopic tools **110-180** may include a sensor **200**. In this manner, in addition to LG **28** including sensor **30** and endoscopic tools **50-90**, laparoscopic tools **110-180** may be tracked with tracking system (FIG. **1**). As a distal portion of laparoscopic tools **110-180** is advanced through the patient "P's" thoracic cavity, the sensor **200** enables tracking of the distal portion of laparoscopic tools **110-180**, as detailed above. Thus, with additional reference to FIG. **1**, work station **12**, and/or any other suitable display may be configured to display the three-dimensional model and selected pathway, both of which were generated during the planning phase (as detailed above), along with the current location of the sensors **100**, **200** disposed in the distal portion of endoscopic tools **50-90** and laparoscopic tools **110-180** to facilitate navigation of the distal portion of endoscopic tools **50-90** and laparoscopic tools **110-180** to the area of interest and/or manipulation of the distal portion of endoscopic tools **50-90** and laparoscopic tools **110-180** relative to the area of interest.

[0053] In some embodiments, the clinician may reference the layers of the three-dimensional multi-layered model **11**, as described above, to improve the placement of access ports **36***a*, **36***b*. Also, clinician may reference the layers of the three-dimensional multi-layered model **11** to improve the navigation and movement of the endoscopic tools **50-90** and laparoscopic tools **110-180**, which will enhance the effectiveness of the treatment for the patient "P" by promoting better navigation of endoscopic tools **50-90** and laparoscopic tools **110-180** to the area of interest.

[0054] Having inserted the endoscopic tools **50-90**, placed the laparoscopic access ports **36***a*,**36***b*, and inserted the laparoscopic tools **110-180** through the laparoscopic access ports **36***a*,**36***b*, the clinician may now use both approaches to simultaneously manipulate, analyze, and treat the area of interest. For example, despite the best efforts of surgeons, identification of specific physiological structures of the lungs remains challenging. To assist in identifying structures, following navigation of a endoscopic navigation catheter **26** to an area of interest identified in the planning phase relying on the navigation system, a light source can be employed to illuminate the location such that the clinician can visualize the area of interest through a laparoscope inserted through one of the laparoscopic access ports **36***a*, **36***b*. Similarly, the endoscopic navigation catheter **26** inserted bronchoscopically may be used to deposit one or more markers, which can be identified using fluoroscopy or other imaging modalities to assist in the laparoscopic procedure. Similarly, the endoscopic navigation catheter **26** can be used to inject dyes or fluorescent materials at a target site enabling them to be better visualized by the clinician. Still further, following treatment laparoscopically (e.g., a lung resection or lobectomy), the bronchoscopically inserted endoscopic navigation catheter **26** may be used to inject one or more sealants to the area to assist in vessel closure and bleeding cessation. Similarly, an ultrasound probe (not specifically shown) may be used to interrogate tissue to confirm placement of the endoscopic navigation catheter **26** and the location of the area of interest. This might similarly be undertaken employing a fiber optic system inserted via the endoscopic navigation catheter **26** to interrogate the tissue. This interrogation could be either within the visible spectrum to provide visual tissue identification, or non-visible spectrum including infrared, ultraviolet, and others and may be used in combination with the use of dyes and fluorescent materials described above. Still further, combination treatments, e.g., microwave or chemical ablation can be undertaken bronchoscopically followed by traditional resection of the treated tissue. Yet another technique might employ cryo-ablation systems to freeze tissue, either lethally or sub-lethally, in order to promote vasoconstriction and limit blood flow to an area of interest to be treated.

[0055] Additionally, where the area of interest is concealed by other parts of the lungs, one or more of the endoscopic tools **50-90** may be employed bronchoscopically to capture tissue internally and move the concealing tissue (e.g., a portion of a lung lobe) to provide better access to the laparoscopic tools **110-180**. The use of endoscopic navigation catheter **26** as an internal port allows repositioning/stabilization/maneuvering without the disadvantages associated with an additional external access port, and thus, the endoscopic navigation catheter **26** obviates the need for multiple external access ports. Also, the addition of an internal port may assist in alleviating the problem regarding a single-port VATS procedure and the geometries involved with operating on the lung and the chest cavity. To appropriately alleviate the geometric challenges associated with performing a single-port VATS within the chest cavity, the proper triangulation of the camera **110**, access ports **36***a*, **36***b*, and endoscopic tools **50-90** should be achieved. The proper triangulation of camera **110**, access ports **36***a*, **36***b*, and endoscopic tools **50-90** allows the clinician to properly manipulate the patient's "P's" tissue and avoid any unnecessary nerve damage often associated with laparoscopic procedures performed on the chest cavity. Additionally, combining laparoscopic access ports **36***a*, **36***b* and endoscopic navigation catheter **26** the clinician may have multiple views of the patient "P's" thoracic cavity. Work station **12** may be configured to receive the location data from tracking system and display the current location of all sensors on the three-dimensional model and relative to the selected pathway generated during the planning phase. Thus, navigation of endoscopic tools **50-90**, LG **28** including sensor **30**, and/or laparoscopic tools **110-180** to the area of interest and/or manipulation of laparoscopic tools **110-180** and endoscopic tools **50-90** relative to the area of interest, as detailed above, can be readily achieved. Work station **12** may be configured to have a multi-divided screen that simultaneously displays multiple views. Clinician may select a visual configuration of work station **12** to include combination of multiple views, such as, one configuration may display the three-dimensional images generated during the planning phase, tracking of endoscopic tools **50-90** and laparoscopic tools **110-180** within patient's "P's" airways, and the images generated by camera **110**; another configuration may display the three-dimensional images generated during the planning phase, tracking of endoscopic tools **50-90** and laparoscopic tools **110-180** with patient's "P's" airways, and the images generated by camera **90**; even another configuration may display the tracking of endoscopic tools **50-90** and laparoscopic tools **110-180** and the images generated by camera **110**, and the images generated by camera **90**; even another configuration may display the selected layer of the three-dimensional multi-layered model **11** generated during the planning phase; however, it is understood that work station **12** may include other visual configuration options for the clinician to choose.

[0056] While several embodiments of the disclosure have been shown in the drawings, it is not intended that the disclosure be limited thereto, as it is intended that the disclosure be as broad in scope as the art will allow and that the specification be read likewise. Therefore, the above description should not be construed as limiting, but merely as exemplifications of particular embodiments.

What is claimed is:

1. A surgical system comprising:

an endoscopic navigation catheter configured for navigation of a luminal network to an area of interest;

at least one laparoscopic access port, placed in proximity to the area of interest;

a laparoscopic tool configured for insertion through the at least one laparoscopic access port; and

an endoscopic tool configured for insertion through the endoscopic navigation catheter, wherein the laparoscopic tool and endoscopic tool enable a combined laparoscopic and endoscopic approach to the area of interest.

2. The surgical system according to claim **1**, further comprising a double lumen endotracheal tube.

3. The surgical system according to claim **1**, further comprising an electromagnetic sensor operatively associated with the endoscopic navigation catheter.

4. The surgical system according to claim **3**, further comprising a locatable guide insertable through the endoscopic navigation catheter, the electromagnetic sensor is formed on the locatable guide.

5. The surgical system according to claim **1**, wherein the endoscopic tool includes an electromagnetic sensor positioned on a distal portion of the endoscopic tool, the distal portion is trackable by a tracking system.

6. The surgical system according to claim **1**, wherein the laparoscopic tool includes an electromagnetic sensor positioned on a distal portion of the laparoscopic tool, the distal portion is trackable by a tracking system.

7. The surgical system according to claim **2**, wherein the endoscopic navigation catheter is configured for placement within one of the lumens of the double lumen endotracheal tube.

8. The surgical system according to claim **7**, wherein the endoscopic navigation catheter is configured as an internal port allowing manipulation of the area of interest.

9. The surgical system according to claim **1**, wherein the endoscopic tool is selected from a group consisting of a biopsy forceps, a cytology brush, an aspirating needle, an ablation catheter, and a camera.

10. The surgical system according to claim **1**, wherein the laparoscopic tool is selected from a group consisting of a camera, a lung forceps, a surgical stapler, a vessel sealer, a collection bag, a morcellator, an ablation catheter, and a cautery device.

11. A method, comprising:

placing a double lumen endotracheal tube within a luminal network of a patient;

inserting an endoscopic navigation catheter within a lumen of the double lumen endotracheal tube;

inserting an endoscopic tool through the endoscopic navigation catheter;

implanting one or more laparoscopic access ports adjacent to an area of interest;

inserting a laparoscopic tool through at least one of the laparoscopic access ports;

performing a combined laparoscopic and endoscopic procedure to the area of interest.

12. The method according to claim **11**, further comprising reviewing image data of the patient to identify the area of interest and planning at least one pathway to identified area of interest.

13. The method according to claim **12**, further comprising performing a survey to collect location data of the luminal network, wherein the survey utilizes the endoscopic navigation catheter and an electromagnetic sensor operatively associated therewith.

14. The method according to claim **13**, further comprising registering the collected location data of the luminal network with the image data of the patient.

15. The method according to claim **14**, wherein the registering the image data occurs before placement of the double lumen endotracheal tube within the luminal network of the patient.

16. The method according to claim **15**, further comprising navigating the endoscopic navigation catheter through the lumen of the double lumen endotracheal tube to the area of interest.

17. The method according to claim **16**, wherein the electromagnetic sensor is embodied on a locatable guide and further comprising removing the locatable guide including the electromagnetic sensor from the endoscopic navigation catheter.

18. The method according to claim **17**, further comprising performing an endoscopic procedure with the endoscopic tool.

19. The method according to claim **11**, further comprising navigating the laparoscopic tool to the area of interest.

20. The method according to claim **19**, further comprising performing a laparoscopic procedure with the laparoscopic tool.

* * * * *

patsnap

专利名称(译)	在腹腔镜手术中使用内窥镜导管作为端口的系统和方法
公开(公告)号	US20180036084A1
公开(公告)日	2018-02-08
申请号	US15/661237
申请日	2017-07-27
[标]申请(专利权)人(译)	柯惠有限合伙公司
申请(专利权)人(译)	COVIDIEN LP
当前申请(专利权)人(译)	COVIDIEN LP
[标]发明人	KRIMSKY WILLIAM S
发明人	KRIMSKY, WILLIAM S.
IPC分类号	A61B34/20 A61B34/10 A61B1/018 A61B1/267 A61B17/34 A61B1/00
CPC分类号	A61B34/20 A61B17/3423 A61B1/00087 A61B1/00154 A61B2034/107 A61B1/267 A61B34/10 A61B2034/2051 A61B1/018 A61B1/0005 A61B1/2676 A61B17/3421 A61B17/3474 A61B17/3478 A61B34/25 A61B2017/00278 A61B2017/00809 A61M16/0404 A61M16/0486
优先权	62/369986 2016-08-02 US
外部链接	Espacenet USPTO

摘要(译)

一种手术系统，包括内窥镜导航导管，至少一个腹腔镜进入端口，腹腔镜工具和内窥镜工具。内窥镜导航导管被配置用于将管腔网络导航到感兴趣的区域。至少一个腹腔镜进入端口邻近感兴趣区域放置。腹腔镜工具构造成用于插入穿过至少一个腹腔镜进入端口，并且内窥镜工具构造成用于插入穿过内窥镜导航导管。腹腔镜工具和内窥镜工具使得能够对感兴趣的区域进行组合的腹腔镜和内窥镜方法。