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ARTICULATION MECHANISMS AND METHODS OF USE

Abstract

An accessory device for use with a medical device includes a first cuff secured to a distal end of the medical device, a second cuff secured to the medical device proximal of the first cuff, an actuator, and at least one actuation wire extending from the first cuff, through the second cuff, to the actuator.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS [0001] This application is a continuation of U.S. application Ser. No. 18/586,828, filed on Feb. 26, 2024, which is a continuation of U.S. application Ser. No. 17/322,435, filed on May 17, 2021, now U.S. Pat. No. 11,944,282, issued on Apr. 2, 2024, which claims the benefit of priority from U.S. Provisional Application No. 63/026,363, filed on May 18, 2020, each of which is incorporated by reference herein in its entirety.

TECHNICAL FIELD

[0002] This disclosure relates to endoscopic medical devices and methods of use. In some embodiments, the disclosure relates to an accessory device for one or more medical instruments (e.g., endoscopic accessory tools) associated with an endoscope for articulating the one or more medical instruments independent of actuating an articulation region of the endoscope.

BACKGROUND

[0003] Conventional medical instruments are generally advanced through a catheter, endoscope, or other like device, to a desired location in a patient. Endoscopes may include actuation mechanisms to articulate one or more regions of the endoscope to make passability through a tortuous path easier and/or to access a target site within the body. Articulation of medical instruments advanced within a lumen of the endoscope may be limited by the actuation and the articulation of the endoscope.

[0004] Accordingly, methods of performing medical procedures and medical instruments used in these procedures may require additional maneuverability. For example, when a medical instrument is advanced distally of a distalmost end of the endoscope, the maneuverability of the medical instrument is limited by the articulation of the endoscope. Thus, medical instruments used with conventional endoscopes may be unable to access certain areas of the body due to a tortuous path leading to the treatment site. This disclosure may solve one or more of these problems or other problems in the art. The scope of the disclosure, however, is defined by the attached claims and not the ability to solve a specific problem.

SUMMARY OF THE DISCLOSURE

[0005] According to an aspect, an accessory device for use with a medical device includes a first cuff configured to be secured to a distal end of the medical device, a second cuff configured to be secured to the medical device proximal of the first cuff, an actuator, and at least one actuation wire extending from the first cuff, through the second cuff, to the actuator.

[0006] One or more of the first cuff and the second cuff may include an outer member and an inner member, and wherein the outer member may be configured to compress the inner member against the medical device when one or more of the first cuff and the second cuff is secured to the medical device.

[0007] A material of the inner member may be configured to increase a friction between the inner member and the medical device.

[0008] The inner member may include one or more of a gel, a foam, or a plastic, and the outer member may include one or more of a metal, a ceramic, or an elastic material.

[0009] The accessory device may further include a membrane surrounding a portion of the medical device, wherein the membrane may extend between the first cuff and the second cuff.

[0010] The membrane may include a plurality of ridges separated by valleys.

[0011] The ridges may have a first thickness and the valleys may have a second thickness different than the first thickness

[0012] The actuator may include a slot extending along a longitudinal axis of the actuator and an actuation mechanism configured to move within the slot, wherein the movement of the actuation mechanism within the slot may be configured to move the at least one actuation wire proximally and distally.

[0013] The second cuff may include an actuator lumen extending from a proximal end to a distal end, wherein the actuator lumen may be configured to receive the at least one actuation wire, and wherein the at least one second cuff may define an articulation joint about which the medical device is configured to bend.

[0014] The actuation wire may be fixed to the first cuff, and wherein the actuation wire may be configured to move within the actuator lumen and relative to the second cuff.

[0015] Movement of the actuation wire in the proximal direction may be configured to bend a portion of the medical device from a neutral position, in which the medical device lies along a longitudinal axis of the medical device, toward an articulated position angled relative to the longitudinal axis, and wherein movement of the actuation wire in the distal direction may be configured to move the portion of the medical device from the articulated position toward the neutral position.

[0016] One or more of the first cuff and the second cuff may include two portions, wherein the two portions may be joined together at adjacent first ends by a hinge.

[0017] The first cuff may include an annular ring extending from a sidewall of the first cuff toward a central axis of the first cuff, and wherein a projection may extend from a radially inwardmost edge of the annular ring toward the central axis.

[0018] At least one of the first cuff and the second cuff may be configured to contact a shoulder on a catheter of the medical device, and wherein a longitudinal movement of at least one of the first cuff or the second cuff in a proximal direction relative to the shoulder may be inhibited by contact between at least one of the first cuff or the second cuff and the shoulder.

[0019] At least one of the first cuff or the second cuff may be C-shaped, and wherein the at least one of the first cuff or the second cuff may extend only partially around a circumference of a catheter of the medical device when the accessory device is attached to the medical device.

[0020] According to another aspect, a medical device includes a catheter, a tool at a distal end of the catheter, and an accessory device, including a cuff secured to the catheter or the tool, a pivot member secured to the catheter proximal to the cuff, and an actuation wire fixed to the cuff, extending through the pivot member, and movable relative to the pivot member, wherein movement of the actuation wire relative to the pivot member is configured to articulate the catheter.

[0021] The medical device may further include a handle at a proximal end of the catheter, wherein the handle may include one or more actuators configured to operate the tool, and an actuation mechanism at a proximal end of the actuation wire, wherein movement of the actuation mechanism in a direction parallel to a longitudinal axis of the catheter may be configured to articulate the catheter.

[0022] The pivot member may include a distal end of a sheath, wherein the sheath may be disposed around the catheter, and wherein the sheath may be configured to be moved in a proximal direction or a distal direction to change a distance between the pivot member and the cuff.

[0023] According to another aspect, a method for performing an operation in a body may include advancing a delivery device to a target site via the endoscope, wherein the delivery device defines a

lumen, introducing a medical tool into the lumen, wherein the medical tool includes a catheter, a tool at a distal end of the catheter, and an accessory device including a first member attached to a distal end of the medical tool, a second member attached to the catheter proximal of the first member, and an actuation wire extending from the first member, through the second member, to a proximal end of the accessory device; advancing the distal end of the medical tool distally to a distalmost end of the delivery device, and moving the actuation wire in a proximal direction to cause at least a portion of the catheter extending from the distalmost end of the endoscope to bend. [0024] The method may further include moving the actuation wire in a distal direction after a completion of a medical procedure using the tool; and retracting the distal end of the medical tool proximally of the distalmost end of the delivery device.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0025] The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate various exemplary embodiments and together with the description, serve to explain the principles of the disclosed embodiments.

[0026] FIG. 1 is a schematic of a medical device according to an embodiment;

[0027] FIG. 2 is a perspective view of an accessory device for use with the medical device of FIG. 1;

[0028] FIG. 3A is a perspective view of a distal end of the medical device of FIG. 1;

[0029] FIGS. 3B, 3C, and 3D are perspective views of a distal end of a medical device including an outer membrane;

[0030] FIG. 4 is a perspective view of a distal end of an accessory device of FIG. 1 according to another embodiment;

[0031] FIG. 5A is a perspective view of a medical device according to an embodiment;

[0032] FIGS. 5B, 5C, and 5D are perspective views of cuffs of an accessory device;

[0033] FIG. 6 is a perspective view of a distal end of a medical device according to an example; and

[0034] FIG. 7 is a perspective view of a distal end of a medical device according to another example.

DETAILED DESCRIPTION

[0035] This disclosure is described with reference to exemplary medical systems and medical instruments or tools for accessing a target site, for example, for grasping, cutting, and/or stapling tissue. The medical instruments or tools may include an accessory device to allow the medical instruments or tools to be articulated independent from an endoscope or other catheter, sheath, or delivery device through which the medical instruments or tools may access the target site. This may provide improved medical tool functionality by, e.g., improving maneuverability of the medical instruments, improving access to target sites, and/or approaching target sites from different directions that may not be possible using only the endoscope, the catheter, or other delivery device. However, it should be noted that reference to any particular device and/or any particular procedure is provided only for convenience and not intended to limit the disclosure. A person of ordinary skill in the art would recognize that the concepts underlying the disclosed devices and application methods may be utilized in any suitable procedure, medical or otherwise. This disclosure may be understood with reference to the following description and the appended drawings, wherein like elements are referred to with the same reference numerals.

[0036] For ease of description, portions of the disclosed devices and/or their components are referred to as proximal and distal portions. It should be noted that the term “proximal” is intended to refer to portions closer to a user of the devices, and the term “distal” is used herein to refer to

portions further away from the user. Similarly, “extends distally” indicates that a component extends in a distal direction, and “extends proximally” indicates that a component extends in a proximal direction. Further, as used herein, the terms “about,” “approximately,” and “substantially” indicate a range of values within $\pm 10\%$ of a stated or implied value. Additionally, terms that indicate the geometric shape of a component/surface refer to exact and approximate shapes.

[0037] Embodiments of this disclosure may be used to perform a medical procedure on a tissue in an endo-luminal space, or facilitate the process thereof. According to an example, medical instruments may include an end effector having a resection or cutting mechanism (e.g., an integrated knife), a stapling mechanism (e.g., a stapler), a suction mechanism, a grasping mechanism, a biopsy mechanism, or any other tool used in a medical procedure. The medical instrument may be delivered through an endoscope working channel to the target tissue site. All or parts of the medical instrument could be metallic (such as stainless steel, titanium, or cobalt chrome), plastic (such as polyetheretherketone (PEEK) or the like), or include a shape memory metal (such as Nitinol), a shape memory polymer, a polymer, or any combination of materials. While reference is made herein to an accessory device for use with a medical instrument including a biopsy device with a control mechanism, the described accessory device may be used with any medical instrument, and the medical instrument may be used with or without an endoscope. The accessory device may provide improved articulation of a medical instrument. For example, the accessory device may directly articulate the medical instrument, whereas articulation of an endoscope may change the path (e.g., lumen) through which the medical instrument may travel.

[0038] Referring to FIG. 1, a medical instrument **10** according to an embodiment is shown. Medical instrument **10** includes a handle **20**, a catheter **30** connected to handle **20**, and an end effector assembly **40** (e.g., a biopsy assembly) at a distal end of catheter **30**, opposite handle **20**. An accessory device **50** is attached to handle **20**, catheter **30**, and end effector assembly **40**, as will be described herein. As used herein, an end effector or end effector assembly **40** may be any tool or mechanism at a distal end of catheter **30**. Accessory device **30** may be removable, e.g., may be attached to and removed from a medical instrument, and accessory device **30** may be used with multiple medical instruments during a medical procedure. Medical device **10** may be any device having an end effector, e.g., biopsy forceps, scissors, a needle, a snare, a stapler, or other medical end effector.

[0039] Handle **20** includes a body **22** defining a hole **22a** in body **22** at a proximal end thereof. Catheter **30** is attached at an opposite, distal end of body **22**. A slot **26** extends through body **22** in a direction parallel to a longitudinal axis A of medical instrument **10**. A spool **24** is disposed in slot **26** and moves within slot **26** and along body **22** in a direction parallel to longitudinal axis A. Spool **24** includes two annular protrusions **24a** at a distal end and a proximal end thereof and extending from spool **24** in a direction perpendicular to the direction of longitudinal axis A and the extension of catheter **30**. Annular protrusions **24a** define an annular grip **24b**, which is grasped by a user. For example, a user may place a thumb or a finger in hole **22a** and may grasp annular grip **24b** with two fingers (e.g., the index and middle fingers). The user may move spool **24** proximally and distally along slot **26** to actuate end effector assembly **40**, as discussed herein. It will be understood that handle **20** may be made of any material known in the art, including, but not limited to, a medical grade plastic or rubber, a ceramic, a metal, or a combination thereof. It will also be understood that handle **20** is not limited to the configuration shown in FIG. 1. For example, handle **20** may be any actuating handle known in the art, including, but not limited to, the devices disclosed in U.S. Pat. No. 6,743,185 and/or U.S. Pat. No. 7,762,960, the contents of each of which are incorporated herein by reference in their entirety.

[0040] An actuation wire (not shown) extends distally from the distal end of spool **24**. The actuation wire extends through a hole (not shown) at the distal end of body **22** and into a lumen (not shown) of catheter **30**. Actuation of the actuation wire actuates end effectors (e.g., biopsy jaws, cutting members, or grasping members) of end effector assembly **40**. For example, as spool **24**

moves proximally and distally, the actuation wire is moved proximally and distally and actuates end effector assembly **40** (e.g., by opening or closing jaws of a biopsy device, actuating a needle, or the like). As will be understood, catheter **30** is a generally circular sheath extending from handle **20** along longitudinal axis A, with end effector assembly **40** extending from a distal end thereof. While catheter **30** is described as including a lumen (not shown), catheter **30** may include multiple lumens to accommodate other actuators, wires, and/or lighting or imaging elements. Additionally, or alternatively, catheter **30** may be placed in another, larger catheter endoscope, colonoscope, bronchoscope, ureterscope, sheath, or other like-device (not shown), if use of tools, suction, light-emitting elements, imaging, or the like associated with the larger catheter are desired. It will be understood that the wire may include any material known in the art, including, but not limited to, medical grade plastic, metal, or other resin suitable for actuating and/or maneuvering end effector assembly **40**, as described herein, during medical procedures. Further, it will be understood that catheter **30** may be formed of any medical grade plastic, rubber, resin, or the like that is suitable for use in medical applications.

[0041] As shown in FIGS. **1** and **2**, accessory device **50** includes an actuator **52**, first and second cuffs **56**, **54**, and an actuation wire **51**. First cuff **56** may be attached at a distal end of medical instrument **10**, e.g., may be attached to or attached adjacent to end effector assembly **40**. Second cuff **54** may be attached to medical instrument **10** proximal to first cuff **56**. For example, second cuff **54** may be attached to catheter **30** at a location proximal to first cuff **56**. Actuation wire **51** may extend proximally from first cuff **56** to actuator **52**, via second cuff **54**. A distal end of actuation wire **51** may be attached to first cuff **56**, and a proximal end of actuation wire **51** may be attached to actuation mechanism **52a**. While actuation wire **51** is shown as being a rigid member with, e.g., angled surfaces, it will be understood that actuation wire **51** may be non-rigid and may be, e.g., a cable or the like. Further, actuation wire **51** may be cylindrical, flat, or any other shape suitable for use with medical devices.

[0042] As shown in FIG. **1**, actuator **52** may be attached to a body of handle **20** via a snap fit, adhesive connection, or the like. For example, actuator **52** may be back fed over end effector assembly **40** and catheter **30**, until actuator **52** reaches handle **20**. Actuator **52** may lie over a distal end of handle **20** and remain positioned thereon via a friction fit. Alternatively, actuator **52** may be independent from handle **20** and may be grasped by the user's other hand or by another user. Actuation mechanism **52a** may protrude through a channel **52b** in a surface of actuator **52** and may move along channel **52b**. For example, channel **52b** may extend from a distal end of actuator **52** to a proximal end of actuator **52** along longitudinal axis A of medical instrument **10**. Actuation mechanism **52a** may include a triangular, knob, slider, protrusion, raised surfaces, and/or other shapes to provide a mechanism by which the user may grasp and actuate actuation mechanism **52a**. Interaction with actuation mechanism **52a**, e.g., by a user's thumb or finger, may allow the user to slide actuation mechanism **52a** along channel **52b**. Movement of actuation mechanism **52a** along channel **52b** may cause actuation wire **51** to move proximally and distally and may cause medical instrument **10** to articulate, as will be described herein.

[0043] A distal end of accessory device **50** is shown in FIG. **2**. First cuff **56** is approximately cylindrical. First cuff **56** defines a lumen **59** and includes an inner member **56a** and an outer member **56b**. First cuff **56** may be a ring-shaped member and/or may have a clam-shell configuration. For example, first cuff **56** may include two halves connected by a hinge or clasp **56c** (e.g., a pivot pin), which defines a pivotal axis. The two halves of first cuff **56** may pivot relative to each other about clasp **56a**. This may enable first cuff **56** to be attached and/or removed from medical instrument **10**. First cuff **56** may also include a hole or recess (not shown) which may receive a distal end of actuation wire **56**. The distal end of actuation wire **51** may be fixed in the recess, e.g., via an adhesive, welding, or the like. Alternatively, the distal end of actuation wire **51** may be attached directly to an outer member of first cuff **56**. While only one actuation wire **51** is illustrated, any number of actuation wires **51** may be provided. For example, two, three, four, or

more actuation wires **51** may be attached to the proximal end of first cuff **56** and spaced equally about a circumference of first cuff **56**.

[0044] Inner member **56a** is cylindrical and may include a material that may compress and/or that may increase the friction coefficient between first cuff **56** and catheter **30** or end effector assembly **40**. For example, inner member **56a** may be a gel, a foam, a plastic, or the like. Outer member **56b** may include a more rigid metal, a ceramic, or other material that may compress the material of inner member **56a** when first cuff **56** is attached to catheter **30**. For example, when first cuff **56** is attached to catheter **30**, outer member **56b** may compress inner member **56a**, which may inhibit movement of first cuff **56** relative to catheter **30**. Alternatively, first cuff **56** may slide onto catheter **30** from the distal end. Proximal movement of first cuff **56** along catheter **30**, e.g., longitudinal displacement in a proximal direction, may be prevented based on a diameter of catheter **30**. For example, catheter **30** may be tapered from the proximal end to the distal end. Once the outer diameter of catheter **30** is greater than an inner diameter of first cuff **56**, proximal movement of first cuff **56** may be prevented. As yet another example, outer member **56b** may include a rubber-band like material that may compress around inner member **56a** to prohibit movement of first cuff **56** along catheter **30**.

[0045] Second cuff **54** may have a similar structure as first cuff **56**. For example, second cuff **54** may have an inner member **54a** and an outer member **54b**. Inner member **54a** may include a same or similar material as inner member **56a**, and outer member **54b** may include a same or similar material as outer member **56b**. Second cuff **54** may also define a lumen **59**. Second cuff **54** may also be a ring-shaped member and/or may include two halves attached in a clam shell configuration. For example, a hinge or clasp **54c** may define a pivot axis and may join two halves of outer member **54b**. Similar to first cuff **56**, the two halves of second cuff **54** may rotate about the pivot axis defined by clasp **54c** when attaching or detaching second cuff **54** to catheter **30**. For example, outer member **54b** may compress inner member **54a** against catheter **30**, as discussed above relative to first cuff **56**. Alternatively, similar to first cuff **56**, an inner diameter of second cuff **54** may have a diameter smaller than an outer diameter of a portion of catheter **30**. In this manner, proximal movement of second cuff **54** may be prevented once second cuff **56** reaches a position on catheter **30** where the outer diameter of catheter **30** is greater than the inner diameter of second cuff **54**.

[0046] Second cuff **54** also includes an actuator lumen **58** extending from a distal end to a proximal end of second cuff **54**. Actuator lumen **58** may be formed in outer member **54b** or inner member **54a**. Actuation wire **51** may pass through actuation lumen **58** toward actuator **52**, and actuation wire **51** may move longitudinally within actuation lumen **58** relative to first cuff **54** (e.g., second cuff **54** may slide over wire **51**). While a single actuator lumen **58** is shown, it will be understood that two, three, four, or more actuator lumens may be included based on the number of actuation wires **51**.

[0047] FIG. 3A illustrates accessory device **50** attached to the distal end of catheter **30**. First cuff **56** is attached at the distal end of catheter **30**. Alternatively, first cuff **56** may be attached directly to end effector assembly **40**. Second cuff **54** is attached to catheter **30** at a position proximal to first cuff **56**. During operation, proximal movement of actuation wire **51** may cause tension on first cuff **56** and cause catheter **30** to articulate from a neutral position (e.g., lying along longitudinal axis A), about second cuff **54**. Second cuff **54** acts as an articulation pivot, and catheter **30** bends between cuffs **54**, **56**. Distal movement of actuation wire **51** may cause first cuff **56** to articulate to move catheter **30** from a position offset from longitudinal axis A back to the neutral position. In some instances, catheter **30** may include a shape memory material that may be designed to arrange catheter **30** in the neutral position absent a force, e.g., a force from actuation wire **51** acting on cuffs **54**, **56**. In this instance, removing a proximal force from actuation wire **51** may cause catheter **30** to move toward the neutral position.

[0048] A distance between first cuff **56** and second cuff **54** may determine a bend radius of the

portion of catheter **30** between cuffs **54**, **56**. For example, if the distance between first cuff **56** and second cuff **54** is small, the fine tune articulation control of catheter **30** will be greater than if the distance between first cuff **56** and second cuff **54** is large. Further, the bend radius of the portion of catheter **30** between cuffs **54**, **56** will increase as the distance between first cuff **56** and second cuff **54** increases.

[0049] While only first and second cuffs **56**, **54** are shown, it will be understood that more than two cuffs, e.g., three, four, or more cuffs, may be used. First cuff **56**, e.g., a distalmost cuff, is fixed to the distal end of actuation wire **51**. The remaining cuffs, e.g., a plurality of second cuffs **54**, may each include an actuator lumen **58** for receiving actuation wire(s) **51**. Additional cuffs may alter the bend radius and/or the ability to control the articulation of catheter **30**. For example, additional cuffs may provide additional points about which catheter **30** may be articulated.

[0050] A method of operating medical instrument **10** using accessory device **50** will now be explained. Accessory device **50** may be attached to catheter **30**. For example, first cuff **56** may be attached to the distal end of catheter **30** by clasping the two halves of outer member **56b** to catheter **30**. Second cuff **54** is attached to catheter **30** in a similar manner. In some instances, inner members **54a**, **56a** may be positioned on catheter **30** prior to clasping first and second cuffs **54**, **56** over inner members **54a**, **56a**. Alternatively, inner members **54a**, **56a** may be attached to outer members **54b**, **56b** via adhesive or the like. In this manner, outer members **56b**, **54b** may compress inner members **56a**, **54a**, respectively, against catheter **30**. As another example, first and second cuffs **54**, **56** may be positioned on catheter **30** by inserting the distal end of catheter **30** through lumen **59** of respective first and second cuffs **54**, **56**. A friction force between first and second cuffs **54**, **56**, and catheter **30** may prevent movement of first and second cuffs **54**, **56** along catheter **30** once first and second cuffs **54**, **56** are positioned on catheter **30**.

[0051] Once accessory device **50** is attached to catheter **30**, the distal end of catheter **30** through may be introduced to the body through an incision or a natural orifice, e.g., via the mouth or the anus. In some instances, the distal end of catheter **30** may be inserted into a delivery device (e.g., a duodenoscope or other scope). The distal end of catheter **30** is advanced to a target site. During advancement, or after the distal end of catheter **30** has reached the target site, actuator **52** may be actuated by a user. For example, a user, using a finger or a thumb, may move actuation mechanism **52a** in a distal direction and/or a proximal direction within channel **52b**. As actuation mechanism **52a** is moved, the distal end of catheter **30** is articulated. For example, as actuation mechanism **52a** is moved proximally, the distal end of catheter **30** is articulated from a neutral position to an articulated position. When actuation mechanism **52a** is moved distally, the distal end of catheter **30** is moved from the articulated position to the neutral position. Alternatively, or additionally, catheter **30** may move toward the neutral position based on the material of catheter **30**, e.g., a shape memory material, absent a proximal force applied on actuation wire **51**.

[0052] When using a delivery device (e.g., a duodenoscope or other scope), actuation of accessory device **50** occurs after the distal end of medical instrument **10** exits a distalmost end of the delivery device. In this manner, articulation of medical instrument **10** may be controlled independent of the delivery device. Alternatively, in the situation where the delivery device is not used for introducing medical instrument **10**, e.g., if catheter **30** has sufficient rigidity, accessory device **50** may be used to articulate medical instrument **10** during insertion and/or after end effector assembly **40** reaches the target site. In this manner, medical instrument **10** may be capable of navigating a tortuous path, and/or accessing or approaching the target site from directions that may be not available using the delivery device alone.

[0053] FIGS. **3B** illustrates another example of accessory device **50** including a membrane **60**. Membrane **60** may be a pliable or a semi-pliable covering and may be ultrathin (e.g., a thickness of approximately 0.001 inches to approximately 0.010 inches). Membrane **60** may extend from a proximal end of first cuff **56** to a distal end of second cuff **54**, and connect first cuff **56** to second cuff **56**. Alternatively, membrane **60** may extend from a distal end of first cuff **56** to a proximal end

of second cuff **54**, thereby covering cuffs **54**, **56**. Membrane **60** surrounds catheter **30** and actuation wire **51** and, in some embodiments, may restrict an outward movement of actuation wire **51**, e.g., a movement away from catheter **30**. Membrane **60** may prevent actuation wire **51** from contacting a body wall during actuation of accessory device **50**. According to an example, an outer diameter of a fully expanded membrane of membrane **60** may be approximately twice an outer diameter of catheter **30**. Membrane **60** may be any flexible material suitable for use in medical procedures, e.g., a silicone, a rubber, a plastic, or the like.

[0054] FIG. 3C illustrates another example of a membrane **60'**. In this instance, membrane **60'** may be a bellows or other similar device, and may have a thickness the same as or greater than that of membrane **60**, e.g., approximately 0.001 inches to approximately 0.010 inches. According to this example, a pair of actuators **51a'**, **51b'** extend from handle **20** to first cuff **56** via second cuff **54**. Membrane **60'** may also extend from first cuff **56** to second cuff **54** (as in the FIG. 3B example), and may include a plurality of ridges **64'** and valleys **62'**, defined between adjacent ridges **62'**. Ridges **64'** may comprise thicker or more rigid material than the material between ridges **64'** (which define valleys **62'**). In addition, or alternatively, ridges **64'** may include rings of metal, alloy, or other material embedded in membrane **60'**, to provide relatively more rigidity at ridges **64'**. Membrane **60'** may also be formed of any flexible material suitable for use in medical procedures, e.g., a silicone, a rubber, a plastic, or the like. Actuators **51a'**, **51b'** can be operated independently. If actuator **51b'** is pulled proximally relative to actuator **51a'**, membrane **60'** will assume the configuration shown in FIG. 3D. Catheter **30** will bend in an opposite direction if actuator **51a'** is pulled proximally relative to actuator **51b'**. Both actuators **51a'**, **51b'** can be pulled simultaneously a same amount, resulting in the membrane **60'** expanding outward in a bulbous-like fashion. Membrane **60'** may assist to stabilize the distal end of catheter **30** within a body lumen by having ridges **64'** contact the wall of the body lumen.

[0055] During actuation of accessory device **50** in FIG. 3D, one actuation wire **51a'** may be pushed distally while the other actuation wire **51b'** may be pulled proximally. In this instance, pushing actuation **51a'** distally may cause membrane **60'** to expand outward while catheter **30** is bent toward actuation wire **51b'**. As membrane **60'** bends, ridges **64'** may contact a wall of the body. This may prevent inadvertent contact between actuation wires **51a'**, **51b'** and the body, which may prevent injury to the body during a medical procedure.

[0056] Another example of a first cuff **56'** is shown in FIG. 4. First cuff **56'** is cylindrically shaped and defines a lumen **59** extending from a distal end to a proximal end of first cuff **56'**. First cuff **56'** includes an L-shaped protrusion, e.g., a first segment **56a'** extending approximately parallel to a longitudinal axis of catheter **30** and a second segment **56b'** extending approximately perpendicular to first segment **56a'** and radially inward toward the central longitudinal axis. Second segment **56b'** is configured to connect to a surface of end effector assembly **40**. For example, second segment **56b'** hooks onto a surface of end effector assembly **40** to prevent proximal movement of first cuff **56'**. Second segment **56b'** may engage with a stepped feature, opening, recess, or protrusion of a portion of end effector assembly **40**. In the example shown in FIG. 4, additional proximal movement of first cuff **56'** may cause second segment **56b'** to engage (press against) a surface **42** of a clevis **44** of end effector assembly **40**. Distal movement of first cuff **56'** may be prevented via a friction force between catheter **30** and first cuff **56'**. For example, an inner member of first cuff **56'** may include a material such as the material included in inner member **54a**, **56a**, which may increase the friction coefficient between first cuff **56'** and catheter **30**.

[0057] FIG. 5A illustrates another example of a catheter **30'** having a distal end effector **40'**. Catheter **30'** may include portions of different diameter, e.g., a proximal portion **31'**, a distal portion **33'**, and an intermediate portion **32'** connecting proximal portion **31'** to distal portion **33'**. These different diameters may create transition areas between each portion. For example, a first shoulder or edge **34'** is formed at the transition region between proximal portion **31'** and intermediate portion **32'**, and a shoulder or second edge **35'** is formed at the transition region between intermediate

portion 32' and distal portion 33'. Edges 34', 35' provide suitable locations for attachment of cuffs of accessory device 50. For example, first cuff 56 may be attached to catheter 30' such that first cuff 56 contacts edge 35', and second cuff 54 may be attached to catheter 30' such that second cuff 54 contacts edge 34'. Alternatively, the distalmost cuff may be attached to one or more edges formed on end effector 40'. Other cuffs may be used, however, as discussed herein.

[0058] FIG. 5B illustrates a first cuff 56'', which may be attached at a distal end of a catheter described herein. First cuff 56'' includes a lumen 59. An annular projection 56a'' extends radially inward from and approximately perpendicular to a sidewall of first cuff 56'' toward a central axis of lumen 59. A projection 56c'' may protrude from a surface of annular projection 56a'' toward the central axis of lumen 59. Annular projection 56a'' and/or projection 56c'' may contact a portion of an end effector (e.g., an edge of end effector 40' in FIG. 5A) and may prevent longitudinal displacement in a proximal direction. Actuation wire 51 may be connected to an outer surface of first cuff 56'' via a connector 56b''. Connector 56b'' may include an opening 56d'' and may protrude from the outer surface of first cuff 56'' and may connect to actuation wire 51 via adhesive, laser welding, crimping, or other attachment method.

[0059] FIG. 5C illustrates a second cuff 54''. Second cuff 54'' includes two portions connected by a hinge 54c''. Hinge 54c'' may be a separate member connected to each half of first cuff 54'', or hinge 54c'' may have a reduced amount of material so as to allow the two portions of second cuff 54'' to bend relative to each other (e.g., a live hinge). A protrusion 54a'' on one end of a first portion of second cuff 54'' and a sloped region 54d'' on one end of a second portion of second cuff 54'' may clasp together to connect second cuff 54'' to a medical device (e.g., catheter 30). For example, second cuff 54'' may be attached to catheter 30 by connecting protrusion 54a'' with sloped region 54d'', e.g., protrusion 54a'' may snap onto sloped region 54d''. To disconnect, a force may be applied to protrusion 54a'' sufficient to release protrusion 54a'' from sloped region 54d''. In this instance, second cuff 54'' includes a single layer, e.g., second cuff 54'' does not include a compressive inner layer as with second cuff 54 of FIG. 2. It will be understood, however, that additional layers, such as a compressive layer, may be used with second cuff 54''.

[0060] Actuation wire 51 may be attached to an outer surface of second cuff 54'' via a connector 54b''. Connector 54b'' may protrude from the outer surface of first cuff 54'' and may connect to actuation wire 51 via adhesive, laser welding, crimping, or other attachment method. In this instance, second cuff 54'' may act as the distalmost cuff of accessory device 50. In another example, actuation wire 51 may pass through an opening in connector 54b'' such that actuation wire 54'' may slide proximally and distally relative to second cuff 54''. In this instance, second cuff 54'' may be a proximal cuff of accessory device 50.

[0061] FIG. 5D illustrates a first cuff 56''', which may include a C-shaped configuration. First cuff 56''' may attach to catheter 30 via a snap fit such that first cuff 56''' may be easily removed from catheter 30 after a medical procedure. Alternatively, first cuff 56''' may be secured to catheter 30 via an adhesive, a laser welding, or other attachment means. First cuff 56''' also includes a connector 56a''' on an outer surface, which may be attached to actuation wire 51. Actuation wire 51 may pass through an opening 56b''' in connector 56a'', such that first cuff 56''' may move proximally and distally relative to actuation wire 51. Alternatively, first cuff 56''' may be fixed to actuation wire 51 to prevent relative movement. A stop 57 is provided at a distal end of actuation wire 51. Stop 57 has a larger diameter than actuation wire 51 to prevent actuation wire 51 from exiting cuff 54b'' upon proximal movement of actuation wire 51.

[0062] FIG. 6 illustrates a first cuff 56'''. First cuff 56''' may include a plurality of openings to receive actuation wire 51. Actuation wire 51 may pass through a first opening 56a''' in first cuff 56''' in a distal direction. Actuation wire 51 may then loop around a clevis 42 of end effector assembly 40. A distalmost end 51a of actuation wire 51 is received in a second opening 56d''' in first cuff 56''' and may be secured to first cuff 56'''. Second opening 56d''' may be C-shaped or may have another geometry such that actuation wire 51 may be attached via a snap fit, an adhesive,

or another suitable attachment mechanism. It will be understood that actuation wire **51** may loop around any portion of end effector assembly **40**, to fixedly couple cuff **56** to the distal end of the medical instrument.

[0063] FIG. 7 illustrates an example of an accessory device **50'**. Accessory device **50'** includes a sheath **70** having a lumen that slides over catheter **30**. An actuation wire **51'** includes a hook **51a'** at a distal end. Hook **51a'** is configured to grasp onto any opening, protrusion, edge, or other area suitable for connection on end effector assembly **40'**. Alternatively, hook **51a'** may grasp an edge of a distal end of catheter **30**. In this manner, longitudinal movement of hook **51a'** in a proximal direction relative to end effector assembly **40'** may be prevented.

[0064] Sheath **70** may extend from a proximal handle to a position proximal of a distalmost end of catheter **30**. A distance between a distal end **72** of sheath **70** and hook **51a'** defines an articulation region of catheter **30**. For example, distal end **72** may act as a pivot point about which the portion of catheter **30** between distal end **72** and hook **51a'** bends. In this instance, a proximal movement of actuation wire **51'** causes the portion of catheter **30** between hook **51a'** and distal end **72** of sheath **70** to bend. Sheath **70** may be telescoping such that a position of distalmost end **72** of sheath **70** relative to hook **51a'** may be changed, e.g., by two inches or less, as shown by arrow B. Changing the distance between distal end **72** and hook **51a'** may allow catheter **30** to achieve larger or smaller bend radiuses. During a medical procedure, the user may move sheath **70** distally or proximally to change this distance according to a desired bend radius. Once the desired distance between distal end **72** and hook **51a'** is achieved, sheath **70** may be locked by any mechanism sufficient for preventing movement of sheath **70** during the medical procedure.

[0065] According to another example, medical instrument **10** and accessory device **50** attached thereto may be introduced outside a delivery device, e.g., a scope. For example, medical instrument **10** may be attached to an outer surface of the delivery device via a rail, a cuff, or other attachment mechanism. Actuation of accessory device **50** may allow the user to bend a portion of medical instrument **10**. In this manner, bending of medical instrument **10** may not be limited by a lumen of the delivery device. Additionally, or alternatively, a stability device (e.g., an inflatable balloon or other device for anchoring the delivery device within the body) may be used with the medical device and accessory device **50**. The stability device may assist in inhibiting movement of the medical device when accessory device **50** is actuated and medical instrument **10** is bent.

[0066] It will be understood that, unless specifically set forth herein, any material known in the art may be used for the various elements. For example, features may include a medical grade plastic or rubber, a ceramic, a metal, or a combination thereof. It will be understood that any cuff described herein may be used as the distal cuff or the proximal cuff, unless explicitly stated otherwise. For example, endoscopes include various configurations and may be suitable to one cuff over another based on the geometry of the medical device. Further, cuffs from different embodiments may be used together, e.g., first cuff **56** may be used with second cuff **54**, depending on the geometry of these endoscopes.

[0067] It will be apparent to those skilled in the art that various modifications and variations can be made to the disclosed device without departing from the scope of the disclosure. For example, accessory device **50** may be used with any medical instrument, with or without an associated endoscope or delivery device for introducing the medical instrument into the body. While mechanisms are disclosed for attaching cuffs **54**, **56** to catheter **30**, it will be understood that cuffs **54**, **56** may be attached using an adhesive or the like. In this manner, accessory device **50** may provide improved and/or additional articulation of a medical instrument or tool. Other embodiments of the disclosure will be apparent to those skilled in the art from consideration of the specification and practice of the invention disclosed herein. It is intended that the specification and examples be considered as exemplary only, with a true scope and spirit of the invention being indicated by the following claims.

Claims

- 1.** A medical device comprising: an actuator; a catheter; an end effector assembly at a distal end of the catheter; and an actuation wire having a proximal portion coupled to the actuator and a distal portion coupled to the catheter or the end effector assembly, such that actuation of the actuator articulates a distal portion of the catheter, wherein the distal portion of the actuation wire includes a hook or a loop for coupling to the catheter or the end effector assembly.
- 2.** The medical device of claim 1, wherein the medical device includes a cuff removably coupled to the catheter, wherein the actuation wire is coupled to the cuff.
- 3.** The medical device of claim 2, wherein the loop or the hook wraps around a clevis of the end effector assembly.
- 4.** The medical device of claim 3, wherein the cuff includes a first opening and a second opening, wherein the first opening and the second opening are each proximal of the clevis, and wherein the actuation wire extends through the first opening and the second opening.
- 5.** The medical device of claim 4, wherein the second opening is C-shaped and affixed to a free end of the actuation wire via a snap fit or an adhesive.
- 6.** The medical device of claim 3, wherein a portion of the actuation wire that wraps around the clevis is distal of all other portions of the actuation wire.
- 7.** The medical device of claim 1, wherein, the hook or the loop extends into an opening at a distalmost end of the catheter.
- 8.** The medical device of claim 7, further comprising a sheath that surrounds a portion of the catheter, wherein, between a distalmost end of the sheath and a distalmost end of the catheter, at least a portion of the actuation wire is external to the sheath and external to the catheter.
- 9.** The medical device of claim 8, wherein, proximally of the distalmost end of the sheath, the actuation wire is external to the catheter and inside of the sheath.
- 10.** The medical device of claim 1, wherein movement of the actuation wire a proximal direction bends the distal portion of the catheter from a neutral position to an articulated position, and wherein movement of the at least one actuation wire in a distal direction moves the distal portion of the catheter from the articulated position toward the neutral position.
- 11.** A medical device comprising: a catheter; an end effector assembly at a distal end of the catheter; and an accessory device, including: an actuator; a cylindrical member removably positioned around at least a portion of the catheter; and an actuation wire having a proximal portion coupled to the actuator and a distal portion coupled to the catheter or the end effector assembly, such that actuation of the actuator articulates a distal portion of the catheter.
- 12.** The medical device of claim 11, wherein the tubular member is a sheath, wherein the sheath includes a distal end that is proximal of a distal of the catheter, and wherein the actuation wire includes a distal hook configured to couple to a distalmost opening of the catheter.
- 13.** The medical device of claim 12, wherein a distance between the distal end of the sheath and the distal end of the catheter defines an articulation region of catheter, wherein the sheath is movable relative to the catheter, and wherein movement of the sheath changes a size of the articulation region.
- 14.** The medical device of claim 1, wherein the tubular member is a cuff, wherein the actuation wire is coupled to the cuff, and wherein the actuation wire includes a distal loop that wraps around a clevis of the end effector assembly.
- 15.** The medical device of claim 14, wherein the cuff includes a first opening and a second opening, wherein the first opening and the second opening are each proximal of the clevis, and wherein the actuation wire extends through the first opening and the second opening.
- 16.** A medical device comprising: an actuator; a catheter; an end effector assembly at a distal end of the catheter; and an actuation wire having a proximal portion coupled to the actuator and a distal

portion that is hooked to a distalmost opening of the catheter or wrapped around a portion of the end effector assembly, such that actuation of the actuator articulates a distal portion of the shaft.

17. The medical device of claim 16, further comprising a tubular member that surrounds at least a portion of the catheter.

18. The medical device of claim 17, wherein the tubular member is a sheath, wherein the sheath is disposed proximally of a distal end of the catheter.

19. The medical device of claim 18, wherein a distance between a distal end of the sheath and the distal end of the shaft defines an articulation region of the shaft, wherein proximal movement of the sheath relative to the shaft increases an area of the articulation region, and wherein distal movement of the sheath relative to the shaft decreases the area of the articulation region.

20. The medical device of claim 17, wherein the tubular member is a cuff, wherein the actuation wire is coupled to the cuff, wherein the cuff includes a first opening and a second opening, wherein the first opening and the second opening are each proximal of a clevis of the end effector assembly, and wherein the actuation wire extends through the first opening and the second opening and wraps around the clevis.
