# Systems, Methods, and Devices for Monitoring and Treatment of Tissues within and/or Through a Lumen Wall

## CROSS-REFERENCE TO RELATED APPLICATION

**[0001]** The present application is ~~an~~ a national stage application of ~~international~~ International A~~a~~pplication No. PCT/US2013/067726 which claims benefit of and priority to U.S. Provisional Application Ser. No. 61/722,264 filed on Nov. 5th, 2012, entitled "Systems and Methods for Treatment of and/or Through a Lumen Wall", by Landy Toth et al., the entire contents of which are incorporated by reference herein for all purposes.

## BACKGROUND

### Technical Field

**[0002]** The present disclosure relates to the field of monitoring and/or surgical modification of neurological and/or receptor functionality and activity. The present disclosure also relates to catheter based systems for use in nerve and/or receptor monitoring, electrophysiological monitoring, and/or surgical procedures.

### Background

**[0003]** Congestive heart failure, hypertension, diabetes, sleep apnea, and chronic renal failure have many different initial causes; however, all may include some form of sympathetic hyperactivity. Sensory receptors and sympathetic nerves communicate signals with sympathetic centers located in the spinal cord and brain via afferent renal nerve activity, increasing systemic sympathetic tone; meanwhile, through efferent activity, renal nerves and arteries participate in sympathetic hyperactivity in response to signals from the brain, further increasing systemic sympathetic tone.

**[0004]** Sympathetic activation can initially be beneficial but eventually becomes maladaptive. In a state of sympathetic hyperactivity, a number of pathological events take place: abnormalities of hormonal secretion such as increased catecholamine, renine and angiotensin II levels, increased blood pressure due to peripheral vascular constriction and/or water and sodium retention, renal failure due to impaired glomerular filtration and

**[0011]** Another objective is to provide, systems, devices, and methods for interfacing with the tissues of the wall of a lumen as well as tissues exterior to the lumen, via intra lumen access (e.g. via minimally invasive procedure, via catheter access, etc.).

**[0012]** The above objectives are wholly or partially met by devices, systems, and methods according to the appended claims in accordance with the present disclosure. Features and aspects are set forth in the appended claims, in the following description, and in the annexed drawings in accordance with the present disclosure.

**[0013]** According to a first aspect there is provided, a microsurgical tool for monitoring and/or altering electrophysiological activity within the vicinity of a lumen within a body, the microsurgical tool including an elongate member with a distal tip and a control end, the distal tip thereof shaped and dimensioned so as to fit within the lumen, the elongate member shaped and dimensioned so as to extend from an entry site on the body into the lumen; and one or more probes configured with a tip, the probes deployably coupled with the distal tip of the elongate member, electrically, mechanically, and/or fluidly coupled to the control end of the elongate member, the tip of the probe shaped so as to penetrate into and/or through a wall of the lumen upon deployment from the elongate member, one or more of the probes including one or more electrodes, electrically coupled to the probe, one or more of the electrodes configured to convey a signal associated with and/or to alter the electrophysiological activity upon deployment.

**[0014]** In aspects, the electrophysiological signals may be related to and/or correspond to one or more of water concentration, tissue tone, evoked potential, remotely stimulated nervous activity, sympathetic nervous activity, an electromyographic signal [EMG], a mechanomyographic signal [MMG], a local field potential, an electroacoustic event, vasodialation, vessel wall stiffness, muscle sympathetic nerve activity [MSNA], central sympathetic drive, nerve traffic, combinations thereof, or the like.

**[0015]** In aspects, a microsurgical tool in accordance with the present disclosure may include a microcircuit, electrically coupled to one or more of the electrodes, the microcircuit configured to condition the conveyed signal. In aspects, the microcircuit may be embedded within the elongate member. In aspects, the microcircuit is embedded

into the microsurgical tool and at least a portion of the electrical coupling is provided via the elongate member.

**[0016]** In aspects, a microsurgical tool in accordance with the present disclosure may include a microelectrode configured to interface with an adjacent tissue volume within or beyond the wall of the lumen, the microelectrode having an area of less than 5000 $\mu m^2$~~squm~~, less than 1000 $\mu m^2$~~squm~~, less than 250 $\mu m^2$~~squm~~, or less than 100 $\mu m^2$~~squm~~, and/or one or more stimulating electrodes electrically and mechanically coupled to one or more of the probes and/or the elongate member, the stimulating electrodes configured to provide a stimulating and/or ablating current to a tissue site in the vicinity of the wall of the lumen. In aspects, the microsurgical tool comprises a plurality of stimulating electrodes, the microsurgical tool configured to coordinate stimulating and/or ablating currents between two or more of the stimulating electrodes, the currents passing through the tissue site.

**[0017]** In aspects, one or more probes may include a channel, fluidly coupled with the control end of the elongate member, the microsurgical tool configured to deliver a diagnostic and/or therapeutic substance to a tissue site in the vicinity of the wall of the lumen via the channel. In aspects, one or more of the electrodes may be configured and positioned so as to monitor the effect of the stimulating and/or ablating current(s), and/or the effect of the substance on the tissue site and/or tissues related thereto. In aspects, one or more of the stimulating electrodes may have an area of greater than 0.1 $mm^2$~~sqmm~~, 0.5 $mm^2$~~sqmm~~, 1 $mm^2$~~sqmm~~, 2 $mm^2$~~sqmm~~, or 10 $mm^2$~~sqmm~~.

**[0018]** In aspects, the diagnostic and/or therapeutic substance may be a chemical, a drug substance, a neuromodulating substance, a neuroblocking substance, an acid, a base, a denervating agent, a neurotoxin, a botulinum toxin, a tetrodotoxin, a tetraethylammonium, a chlorotoxin, a curare, a conotoxin, a bungarotoxin, arsenic, ammonia, ethanol, hexane, nitric oxide, glutamate, resiniferatoxin, alchohol, phenol, capaicin, an anesthetic, lidocaine, tetanus toxin, quaternary ammonium salts, a pachycurare, a leptocurare, acetylcholine, aminosteroids, or a combination thereof. In aspects, the substance may be included within a restraining matrix, a partially biodegradable matrix, or the like for retention in the wall of the lumen.

**[0019]** In aspects, one or more of the probes may be slidingly coupled to the elongate member, sliding of the probe along the length of the elongate member providing the deployment thereof. In aspects, probe deployment may be achieved by movement of an actuator, release of a latch, retraction of a sheath, or the like. In aspects, the microsurgical tool comprises a sheath extending over the elongate member, retraction of the sheath providing the deployment of the probes.

**[0020]** In aspects, the tool may include a stabilizing member coupled to the elongate member, the stabilizing member configured to retain the position of the distal tip of the

elongate member within the lumen upon deployment. Some non-limiting examples of stabilizing members include a balloon, a basket, a plurality of flexible members, a wire cage, an embolic filter, combinations thereof, and the like. In aspects, the stabilizing member may include one or more electrodes, configured to provide a stimulating, and/or ablating current to the wall of the lumen in accordance with the present disclosure.

**[0021]** In aspects, the tool may include one or more steerable probes in accordance with the present disclosure, one or more of the probes is shaped with a curved tip, the steerable probe slidingly and rotate-ably coupled with the control end of the elongate member, so as to be steerably advanced through the wall of the lumen upon deployment.

**[0022]** In aspects, one or more of the probes may include a stabilizing element positioned at a predetermined distance from the tip thereof, the stabilizing element configured so as to limit the depth which the probe can penetrate into the wall of the lumen upon deployment. In aspects, one or more of the probes may include a plurality of electrodes, arranged along a length thereof in relation to the tip thereof, the electrodes configured to convey precise signals pertaining to electrophysiological activity of an adjacent tissue site in the vicinity thereof, impedance between the electrodes, or the like during deployment. In aspects, the conveyed signals may relate to the depth of penetration of the probe into the wall of the lumen, to the proximity of electrophysiologically active tissues in the vicinity of the wall of the lumen in relation to the probe, or the like.

**[0023]** In aspects, one or more of the probes may be sized and dimensioned so as to fit within a precapillary arteriole positioned within the wall of the lumen. Such a probe may have a diameter of less than 1mm, less than 0.5mm, less than 0.125mm, or the like.

**[0024]** According to aspects there is provided, use of a microsurgical tool in accordance with the present disclosure to monitor and/or alter electrophysiological activity in the vicinity of a vessel, an artery, a vein, a tubule, a renal artery, an organ, a kidney, a liver, a gall bladder, a carotid body, a spleen, a pancreas, a prostate, a combination thereof, or the like.

**[0025]** According to aspects there is provided, use of a microsurgical tool in accordance with the present disclosure to perform a surgical procedure within a body.

components of the microsurgical tool, to use one or more of the electrophysiological signals to exclude the anatomical site from a surgical procedure, or the like.

**[0033]** According to aspects there is provided, a method for evaluating sympathetic tone of a subject including, inserting a microsurgical tool in accordance with the present disclosure into the subject within the vicinity of a target organ or vessel via a lumen, deploying one or more probes into the wall of the lumen, recording the electrophysiological signals conveyed by one or more of the probes included in the microsurgical tool; and generating a metric relating to sympathetic tone from the recorded signals.

**[0034]** In aspects, a method in accordance with the present disclosure may include monitoring another physiological parameter remotely from the target organ or vessel to generate a corrective signal and using the corrective signal to remove movement artifacts from the electrophysiological signals.

**[0035]** In aspects, the method may include stimulating one or more anatomical sites in the subject during the recording, and/or diagnosing a medical condition based at least in part upon the metric.

**[0036]** According to aspects there is provided, a method for monitoring and/or altering electrophysiological activity in the vicinity of a vessel, including penetrating an electrode into and/or through a wall of the vessel from within; and recording one or more electrophysiological signals from the activity in the vicinity of the electrode.

**[0037]** In aspects, a method in accordance with the present disclosure may include recording one or more of an evoked potential, remote stimulation of nervous activity, an electromyographic signal [EMG], a mechanomyographic signal [MMG], a local field potential, an electroacoustic event, vasodialation, vessel wall stiffness, muscle sympathetic nerve activity [MSNA], central sympathetic drive, tissue tone, nerve traffic, or combinations thereof in the vicinity of the electrode.

**[0038]** In aspects, the method may include electrically isolating the electrode from the lumen of the vessel, steering the trajectory of the electrode during the step of

penetration (in aspects, the steering may be dependent upon the recording), depth of the penetration into the wall of the lumen is dependent upon the recording, –recording

electrophysiological activity from a plurality of electrodes, cancelling one or more movement artifacts from the recordings, delivering a substance to the vicinity of the vessel and recording the effect of the substance on the electrophysiological activity~~.~~, and/or stimulating and/or ablating a tissue in the vicinity of the vessel and recording the effect of the stimulation and/or ablation on the electrophysiological activity.

**[0039]** In aspects, the method may include recording a first electrophysiological activity level, applying energy and/or a substance within the vicinity of the vessel and/or through the vessel wall, then recording a second electrophysiological activity level, and comparing the first and second activity levels to determine if the energy and/or substance application had a significant effect on activity, or if further energy and/or substance should be applied.

**[0040]** In aspects, the method may include determining if sufficient energy has been applied to the treatment site based on the comparison, evaluating the first activity level to determine a suitable treatment site in the vicinity of the organ or vessel, mapping electrophysiological activity in the vicinity of the organ or vessel using the first activity level, applying a stimulus in the vicinity of the organ or vessel, and/or recording electrophysiological activity before, during, and/or after the stimulus.

**[0041]** In aspects, the method may include recording electrophysiological activity in a proximal region and a distal region measured along the length of the organ or vessel as spaced with respect to an energy and/or substance delivery site, to determine if the energy application affected the electrophysiological activity in the vicinity of the delivery site, determining if the energy application was sufficient to form a neural block using the comparison, and/or applying sufficient energy to the treatment site to form a temporary block and assessing if the change in electrophysiological activity is desirable, if so, applying sufficient energy to the treatment site so as to form a substantially irreversible block. In aspects, the energy is in the form of a radio frequency current, an ultrasonic wave, or thermal energy.~~.~~

**[0042]** In aspects, one or more of steps of a method in accordance with the present disclosure may be performed using a microsurgical tool in accordance with the present disclosure.

**[00232]** The surgical system may include other functionality including: angiographic die delivery, saline delivery, temperature monitoring, intra and extra vascular coordination between devices, through wall imaging, through wall current flow, saline provision for internal arterial cooling, and the like.

**[00233]** Figs. 1a-c show aspects of a surgical tool in accordance with the present disclosure. Fig. 1a shows the distal tip of a surgical tool 110 in a deployed state. The tip includes an elongate member 112 configured so as to couple an interfacing tip 118 (i.e. a tip for placement into a body) with a control end 116 (i.e. an end of the surgical tool for interfacing with a connector, controller, etc.). The surgical tool 110 includes one or more probes 114a-f coupled to the elongate member 112 (i.e. a member with an axis about which the member is longer than it is perpendicular thereto), configured so as to slide and/or extend out ~~124~~ from the elongate member during a deployment procedure 124. The elongate member 112 may include one or more channels 115, conduits, recesses, tubes, lumens, or the like configured to convey at least a portion of the one or more of the probes 114a-f and/or a mechanism coupled thereto between the distal tip and the control end 116 of the surgical tool 110. One or more of the probes 114a-f may be oriented so as to pass in a direction at least partially perpendicular to the axis of the elongate member 112 during a deployment procedure 124. One or more of the probes 114a-f and/or the elongate member 112 may include one or more electrodes 120, 122, 126, 130a,b, 134 in accordance with the present disclosure. In aspects, one or more probes 114a may include a channel 127 for delivery of a fluid 128 to a target tissue provided from the control end 116 of the surgical tool 110. One or more of the probes 114b or the elongate member 112 may include a marker band 136 to assist with imaging placement of the probe 114b or the distal tip during a procedure.

**[00234]** In aspects, one or more of the probes 114f may include a stabilizing element 132 in accordance with the present disclosure positioned along the length thereof. The stabilizing element 132 may provide a physical transition point so as to controllably limit the depth of penetration of the probe 114f tip into the lumen wall upon deployment 124. In aspects, the stabilizing element 132 may be positioned less than 4mm, less than 2mm, less than 1mm, or the like away from the tip of the probe 114f.

respect to the elongate member axis 227 (i.e. such that an associated probe extends nearly perpendicularly from the elongate member 210 during deployment).

**[00241]** In aspects, an elongate member 210 with diameter less than 1mm may be fashioned with 4 channel lumens 217, 219, each with an internal diameter of approximately 125um, configured to accommodate 4 associated probes, each with a diameter of 75um – 112um.

**[00242]** In aspects, the tip of the elongate member 210 may be fashioned as an add-on to the central length of the elongate member 210, or manufactured as part of a monolithic elongate member 210 (e.g. fashioned into a single elongate member 210 tube), etc.

**[00243]** In aspects, the channels may be configured to protrude from the tip of the elongate member 210 (i.e. along an axis substantially in parallel with the axis of the elongate member). In such a configuration, a region of one or more probes may be bent such that the probe curves into the wall of the lumen upon deployment from the elongate member 210 during use.

**[00244]** Figs. 3a-d show aspects of a distal tip of a surgical tool 310 in accordance with the present disclosure positioned within a lumen 2 in a body. Fig. 3a shows a radial cross section of the surgical tool 310 and the lumen 2 oriented so as to demonstrate deployment of one or more probes 312a-f from the elongate member 311 into the walls 4 of the lumen 2 and into/towards target tissue 6a-c. The surgical tool 310 is shown with 6 probes 312a-fd, oriented with 120deg between each prove in a plane, and two planes of probes 312a-fd (i.e. a first plane of probes 312a,c,e at a first length along the elongate member 311, and a second plane of probes 312b,d,f at a second length along the elongate member 311). In this case, target tissues 6a-c are shown external to the lumen wall 4 but such tissues may be within the lumen wall, along the edge of the lumen wall, etc.

**[00245]** One or more of the probes 312a-f may include one or more electrodes and/or fluid delivery ports configured to interface with the adjacent tissues upon deployment 314 (i.e. to deliver/sample fluid, and/or electrically interface therewith) from the elongate member 311 thereto. In aspects, the distance into the lumen wall 4 that the probes 312a-f may be deployed 314 could be configured prior to the procedure (e.g. via design aspects,

lumen 14 in accordance with the present disclosure. The probe 340 is shown extending through the lumen wall 12 after being deployed from the elongate member.

**[00249]** Through combination of the above examples, a surgical tool in accordance with the present disclosure, may be configured to treat complex regions of target tissue (e.g. extended regions with isolated patterns, island type patterns, helical patterns, toroidal patterns, etc.), in a substantially controlled manner so as to treat the intended tissues without damaging unintended tissues during the procedure.

**[00250]** The same probes (or other probes included in the system) may be configured in combination with one or more circuits in accordance with the present disclosure to monitor activity in the target tissues, before, during, and/or after treatment to assess the extent of the treatment, to controllably terminate the treatment when a suitable traffic level is observed, and the like.

**[00251]** Figs. 4a-h show aspects of probes in accordance with the present disclosure. Fig. 4a shows aspects of a probe 410 with a plurality of electrodes 412a,b and 414a-d in accordance with the present disclosure situated thereupon. One or more larger electrodes 412a,b may be configured so as to provide treatment currents, stimulation currents, or fashioned to act as reference electrodes, while one or more microelectrodes 414a-d may be configured to monitor activity, stimulate, and/or provide treatment currents to spatially precise regions within the target tissue.

**[00252]** Fig. 4b shows aspects of a probe 416 in accordance with the present disclosure fashioned with a tip electrode 420 in accordance with the present disclosure, the remainder of the probe insulated from the surroundings by an insulating layer 418. The tip of the probe may be honed, so as to allow for penetration of the probe in to tissues without causing substantial damage or requiring excessive force. In aspects, the length 422 of the tip electrode 420 may be designed for an intended purpose (e.g. sensing, stimulation, ablation, blocking, etc.). In aspects, the length 422 of the tip electrode 420 may be more than 0.5mm, more than 1mm, more than 0.5mm so as to support RF ablation procedures. In aspects, the length 422 of the tip electrode 420 may be shorter than 0.25mm, shorter than 0.1mm, shorter than 0.01mm, or the like so as to support stimulation and/or sensing procedures.

## WHAT IS CLAIMED IS:

1. A microsurgical tool for monitoring and/or altering electrophysiological activity within the vicinity of a lumen within a body, the microsurgical tool comprising:

an elongate member with a distal tip and a control end, the distal tip thereof shaped and dimensioned so as to fit within the lumen, the elongate member shaped and dimensioned so as to extend from an entry site on the body into the lumen; and

one or more probes configured with a tip, the probes deploy-ably coupled with the distal tip of the elongate member, electrically, mechanically, and/or fluidly coupled to the control end of the elongate member, the tip of the probe shaped so as to penetrate into and/or through a wall of the lumen upon deployment from the elongate member, one or more of the probes comprising one or more electrodes, electrically coupled to the probe, one or more of the electrodes configured to convey a signal associated with and/or to alter the electrophysiological activity upon deployment.

2. The microsurgical tool in accordance with claim 1, wherein the electrophysiological signals are related to one or more of water concentration, tissue tone, evoked potential, remotely stimulated nervous activity, sympathetic nervous activity, an electromyographic signal [EMG], a mechanomyographic signal [MMG], a local field potential, an electroacoustic event, ~~vasodialation~~vasodilation, vessel wall stiffness, muscle sympathetic nerve activity [MSNA], central sympathetic drive, nerve traffic, or combinations thereof.

~~3.~~ The microsurgical tool in accordance with claim 1 or 2, wherein the electrode is electrically coupled with a microcircuit, the microcircuit configured to condition the conveyed signal, the microcircuit being ~~,~~

~~4.~~3. ~~The microsurgical tool in accordance with claim 3, wherein the microcircuit is~~ embedded into the microsurgical tool and at least a portion of the electrical coupling is provided via the elongate member.

~~5.~~4. The microsurgical tool in accordance with any preceding claim, wherein one or more of the probes comprises a microelectrode configured to interface with an adjacent tissue volume within or beyond the wall of the lumen, the microelectrode having an area of less than 5000 $\mu m^2$~~squm~~, less than 1000 $\mu m^2$~~squm~~, less than 250 $\mu m^2$~~squm~~, or less than 100 $\mu m^2$~~squm~~.

~~6.~~5. The microsurgical tool in accordance with any preceding claim, further comprising one or more stimulating electrodes electrically and mechanically coupled to one or more of the probes and/or the elongate member, the stimulating electrodes configured to provide a stimulating current and/or an ablating current to a tissue site in the vicinity of the wall of the lumen.

~~7.~~6. The microsurgical tool in accordance with claim ~~6~~5, further comprising a plurality of stimulating electrodes, the microsurgical tool configured to coordinate stimulating currents and/or ablating currents between two or more of the stimulating electrodes, the currents passing through the tissue site.

~~8.~~7. The microsurgical tool in accordance with any preceding claim, wherein one or more of the probes comprise~~sing~~ a channel, fluidly coupled with the control end

of the elongate member, the ~~microsurgical~~ tool configured to deliver a diagnostic substance and/or a

therapeutic substance to a tissue site in the vicinity of the wall of the lumen via the channel.

~~9.~~8. The microsurgical tool in accordance with claim ~~6~~5, ~~7~~6 or ~~8~~7, wherein the one or more stimulating electrodes are configured and positioned so as to monitor the effect of the stimulating current and/or ablating current(s), and/or the effect of the substance on the tissue site and/or tissues related thereto.

~~10.~~9. The microsurgical tool in accordance with any one of claims ~~6~~5 – ~~9~~8, wherein the stimulating electrodes have an area of greater than 0.1sqmm, 0.5sqmm, 1sqmm, 2sqmm, or 10sqmm.

~~11.~~10. The microsurgical tool in accordance with any one of claims ~~8~~7 – ~~10~~9, wherein the diagnostic substance and/or therapeutic substance is selected from a chemical, a drug substance, a neuromodulating substance, a neuroblocking substance, an acid, a base, a denervating agent, or a combination thereof.

~~12.~~11. The microsurgical tool in accordance with any one of claims ~~8~~7 – ~~11~~10, wherein the therapeutic substance is a selected from a neurotoxin, a botulinum toxin, a tetrodotoxin, a tetraethylammonium, a chlorotoxin, a curare, a conotoxin, a bungarotoxin, arsenic, ammonia, ethanol, hexane, nitric oxide, glutamate, resiniferatoxin, alchohol, phenol, capaicin, an anesthetic, lidocaine, tetanus toxin, quaternary ammonium salts, a pachycurare, a leptocurare, acetylcholine, aminosteroids, or a combination thereof.

~~13.~~12. The microsurgical tool in accordance with any one of claims ~~8~~7 – ~~12~~11, wherein the therapeutic substance is comprised within a restraining matrix.

~~14.~~13. The microsurgical tool in accordance with claim ~~13~~12, wherein the restraining matrix is at least partially biodegradable.

~~15.~~14. The microsurgical tool in accordance with any preceding claim, wherein one or more of the probes is slidingly coupled to the elongate member, sliding of the probe along the length of the elongate member providing the deployment thereof.

~~16. The microsurgical tool in accordance with any one of claims 1 14, wherein the tool comprises a sheath extending over the elongate member, retraction of the sheath providing the deployment of the probes.~~

~~17.~~ The microsurgical tool in accordance with any preceding claim, comprising a stabilizing member coupled to the elongate member, the stabilizing member being: configured to retain the position of the distal tip of the elongate member within the lumen upon deployment.

~~18. The microsurgical tool in accordance with claim 17, wherein the stabilizing member is;~~ selected from a balloon, a basket, a plurality of flexible members, a wire cage, an embolic filter, or a combination thereof~~.~~; and/or comprising

~~19.~~15. ~~The microsurgical tool in accordance with any one of claims 17 18, wherein the stabilizing member comprises~~ one or more electrodes, configured to provide a stimulating, and/or ablating current to the wall of the lumen.

~~20.~~16. The microsurgical tool in accordance with any preceding claim, wherein one or more of the probes is shaped with a curved tip, and is slidingly and rotate-ably coupled with the control end of the elongate member, so as to be steerably advanced through the wall of the lumen upon deployment.

~~21.~~17. The microsurgical tool in accordance with any preceding claim, wherein one or more of the probes comprises a stabilizing element positioned at a predetermined distance from the tip thereof, the stabilizing element configured so as to limit the depth which the probe can penetrate into the wall of the lumen upon deployment.

~~22.~~18. The microsurgical tool in accordance with any preceding claim, wherein one or more of the probes comprises a plurality of electrodes, arranged along a length thereof in relation to the tip thereof, the electrodes configured to convey precise signals pertaining to electrophysiological activity of an adjacent tissue site in the vicinity thereof and/or impedance between the electrodes during deployment.

~~23. The microsurgical tool in accordance with claim 22, wherein the conveyed signals relate to the depth of penetration of the probe into the wall of the lumen.~~

~~24.~~19. The microsurgical tool in accordance with claim ~~22 or 23~~18, wherein the conveyed signals relate to the proximity of electrophysiologically active tissues in the vicinity of the wall of the lumen in relation to the probe.

~~25.~~20. The microsurgical tool in accordance with any one of claims 1 – ~~24~~19, wherein one or more of the probes is sized and dimensioned so as to fit within a precapillary arteriole positioned within the wall of the lumen.

~~26. Use of a microsurgical tool in accordance with any one of claims 1 – 25, to monitor and/or alter electrophysiological activity in the vicinity of a vessel, an artery, a vein, a tubule, a renal artery, an organ, a kidney, a liver, a gall bladder, a carotid body, a spleen, a pancreas, a prostate, or a combination thereof.~~

~~27. Use of a microsurgical tool in accordance with any one of claims 1 – 25, to perform a surgical procedure within a body.~~

~~28. Use of a microsurgical tool in accordance with any one of claims 1 – 25, to determine the extent of a surgical procedure within a body.~~

~~29. Use of a microsurgical tool in accordance with any one of claims 1 – 25, to perform a renal denervation procedure.~~

~~30. A system for altering electrophysiological activity in the vicinity of an anatomical site in the vicinity of an organ or vessel in a body accessible via a lumen, comprising:~~

~~a microsurgical tool in accordance with any one of claims 1 – 25, configured to monitor the electrophysiological activity in the vicinity of the site, and to perform a surgical procedure on the anatomical site; and~~

~~a control unit configured to accept signals from the microsurgical tool, and to adjust the surgical procedure dependent upon the signals, to display the signals, to evaluate the surgical procedure dependent upon the signals, to plan a surgical path for the surgical procedure dependent upon the signals, and/or to determine the extent of the procedure dependent upon the signals.~~

~~31. The system in accordance with claim 30, wherein the surgical procedure is selected from an ablation, an excision, a cut, a burn, a radio frequency ablation, a cryoablation, a radiosurgical procedure, delivery of energy, an ultrasonic ablation, an abrasion, a biopsy, delivery of a substance, or a combination thereof.~~

~~32.~~21. ~~The system in accordance with claim 30 or 31, further comprising a stimulation electrode and/or ablation electrode configured so as to convey a pulsatile and/or a radio frequency signal to the anatomical site or a site coupled thereto from the control unit, the~~

~~microsurgical tool configured to convey one or more feedback signals related to the pulsatile and/or radio frequency signals back to the control unit.~~

~~33. The system in accordance with claim 32, wherein one or more of the feedback signals are related to an electrode impedance, a bioimpedance, a local electrical field, and/or an electrophysiological response to the pulsatile and/or radio frequency signal.~~

~~34. The system in accordance with any one of claims 30-33, wherein the control unit is configured to use one or more of the electrophysiological signals to locate the anatomical site with respect to one or more components of the microsurgical tool.~~

~~35. The system in accordance with any one of claims 30-34, wherein the control unit is configured to use one or more of the electrophysiological signals to exclude the anatomical site from a surgical procedure.~~

~~36. A method for evaluating sympathetic tone of a subject, comprising:~~

~~inserting a microsurgical tool in accordance with any one of claims 1—25 into the subject within the vicinity of a target organ or vessel via a lumen;~~

~~deploying one or more probes into the wall of the lumen;~~

~~recording the electrophysiological signals conveyed by one or more of the probes comprised in the microsurgical tool; and~~

~~generating a metric relating to sympathetic tone from the recorded signals.~~

~~37. The method in accordance with claim 36, comprising monitoring another physiological parameter remotely from the target organ or vessel to generate a corrective signal and using the corrective signal to remove movement artifacts from the electrophysiological signals.~~

~~38. The method in accordance with one of claims 36 or 37, comprising stimulating one or more anatomical sites in the subject during the recording.~~

~~39. The method in accordance with any one of claims 36 – 38, comprising diagnosing a medical condition based at least in part upon the metric.~~

~~40.~~22. A method for monitoring and/or altering electrophysiological activity in the vicinity of a vessel, comprising:

- penetrating an electrode into and/or through a wall of the vessel from within; and
- recording one or more electrophysiological signals from the activity in the vicinity of the electrode.

~~41.~~23. The method in accordance with claim ~~40~~22, comprising recording one or more of an evoked potential, remote stimulation of nervous activity, an electromyographic signal [EMG], a mechanomyographic signal [MMG], a local field potential, an electroacoustic event, vasodialation, vessel wall stiffness, muscle sympathetic nerve activity [MSNA], central sympathetic drive, tissue tone, nerve traffic, or combinations thereof in the vicinity of the electrode.

~~42.~~24. The method in accordance with claim ~~40~~22 or ~~41~~23, comprising electrically isolating the electrode from the lumen of the vessel.

~~43. The method in accordance with any one of claims 40 – 42, steering the trajectory of the electrode during the step of penetration.~~

~~44. The method in accordance with claim 43, wherein the steering is dependent upon the recording.~~

~~45. The method in accordance with any one of claims 40 – 44, wherein a depth of the penetration into the wall of the lumen is dependent upon the recording.~~

~~46.~~25. The method in accordance with any one of claims ~~40~~22 – ~~45~~24, comprising recording electrophysiological activity from a plurality of electrodes.

~~47.~~26. The method in accordance with any one of claims ~~40~~22 – ~~46~~25, comprising cancelling one or more movement artifacts from the recordings.

~~48.~~27. The method in accordance with any one of claims ~~40~~22 – ~~47~~26, comprising delivering a substance to the vicinity of the vessel and recording the effect of the substance on the electrophysiological activity.

~~49. The method in accordance with any one of claims 40 – 48, comprising stimulating and/or ablating a tissue in the vicinity of the vessel and recording the effect of the stimulation and/or ablation on the electrophysiological activity.~~

~~50.~~28. The method in accordance with any one of claims ~~40~~22 – ~~49~~27, comprising recording a first electrophysiological activity level, applying energy and/or a substance within the vicinity of the vessel and/or through the vessel wall, then recording a second electrophysiological activity level, and comparing the first and second activity levels to determine if the energy and/or substance application had a significant effect on activity, or if further energy and/or substance should be applied.

~~51.~~29. The method in accordance with claim ~~50~~28, comprising determining if sufficient energy has been applied to the treatment site based on the comparison.

~~52. The method in accordance with claim 50 or 51, comprising evaluating the first activity level to determine a suitable treatment site in the vicinity of the organ or vessel.~~

~~53.~~30. The method in accordance with ~~any one of~~ claims ~~50~~28 or 29~~–52~~, comprising mapping electrophysiological activity in the vicinity of the organ or vessel using the first activity level.

~~54. The method in accordance with any one of claims 50—53, comprising applying a stimulus in the vicinity of the organ or vessel.~~

~~55. The method in accordance with claim 54, comprising recording electrophysiological activity before, during, and/or after the stimulus.~~

~~56. The method in accordance with any one of claims 50—55, comprising recording electrophysiological activity in a proximal region and a distal region measured along the length of the organ or vessel as spaced with respect to an energy and/or substance delivery site, to determine if the energy application affected the electrophysiological activity in the vicinity of the delivery site.~~

~~57.~~31. The method in accordance with any one of claims ~~50~~28 – ~~56~~30, comprising determining if the energy application was sufficient to form a neural block using the comparison.

~~58.~~32. The method in accordance with claim ~~57~~31, comprising applying sufficient energy to the treatment site to form a temporary block and assessing if the change in electrophysiological activity is desirable, if so, applying sufficient energy to the treatment site so as to form a substantially irreversible block.

~~59.~~33. The method in accordance with any one of claims ~~49~~28 – ~~58~~32 wherein the energy is in the form of a radio frequency current, an ultrasonic wave, or thermal energy.

~~60. The method in accordance with any one of claims 40—59 wherein one or more of the steps are performed using a microsurgical tool in accordance with any one of claims 1—25.~~

~~61. A method for determining a state of a neurological connection along a neurological pathway between one or more regions in a body, comprising:~~

~~applying a pacing signal to the wall of a vessel or to tissues surrounding the vessel in the vicinity of the neurological pathway, via an electrode plunged through the wall of the vessel from within;~~

~~monitoring one or more of water concentration, tone, blood oxygen saturation of local tissues, evoked potential, stimulation/sensing of nervous activity, electromyography, temperature, blood pressure, vasodialation, vessel wall stiffness, muscle sympathetic nerve activity [MSNA], central sympathetic, tissue tone, blood flow, a blood flow differential signal, blood perfusion, a blood analyte level, nerve traffic, or combinations thereof, at one or more sites within the body to generate one or more physiological signals; and~~

~~evaluating the influence of the pacing signal on the physiological signals and determining the state of neurological connection therefrom.~~

~~62. The method in accordance with claim 61, comprising applying energy in the vicinity of the vessel via one or more electrodes so as to induce a neurological block along the neurological pathway.~~

~~63. The method in accordance with claim 62, comprising pacing and monitoring before and after induction of the neurological block.~~

~~64. The method in accordance with claim 63, comprising comparing the physiological signals obtained before the neurological block to those obtained during the neurological block to determine the influence of the neurological block there upon.~~

~~65. The method in accordance with any one of claims 61—64, comprising determining if the neurological block is favorable in terms of treating an underlying disease state in the body.~~

~~66. The method in accordance with claim 65, comprising delivering a substance in the vicinity of the vessel to induce a substantially permanent neurological block if the block is deemed favorable.~~

~~67. The method in accordance with any one of claims 61—66, comprising applying energy in the vicinity of the vessel so as to induce a substantially permanent neurological block along the neurological pathway.~~

~~68. The method in accordance with any one of claims 61—67, comprising monitoring electrophysiological activity at a plurality of sites in the vicinity of the vessel via electrodes plunged through the wall of the vessel from within, in regions proximal and distal to the pacing site and/or to the site of a suspected or known neurological block.~~

~~69. The method in accordance with claim 68, comprising extracting an afferent signal from activity in the distal region and an efferent signal from activity in the proximal region.~~

~~70. The method in accordance with claim 69, comprising comparing activity measured in the proximal region and the distal region to determine if the energy application affected the electrophysiological activity in the vicinity of the target region.~~

~~71. The method in accordance with any one of claims 61—70 wherein one or more of the steps are performed using a microsurgical tool in accordance with any one of claims 1—25.~~

~~72. Use of a method in accordance with any one of claims 61—71 for evaluating the effectiveness of a neuromodulation procedure within a body.~~

~~73. A method for treating a neural body positioned in close proximity to a vessel comprising:~~

~~——Accessing one or more regions of the neural body by threading a device through a precapillary arteriole coupling the neural body to the vessel; and~~

~~——applying energy and/or a substance to the one or more of the regions of the neural body via the device.~~

~~74. The method for treating a neural body in accordance with claim 73, comprising monitoring one or more of water concentration, tissue tone, evoked potential, remotely stimulated nervous activity, sympathetic nervous activity, an electromyographic signal [EMG], a mechanomyographic signal [MMG], a local field potential, an electroacoustic event, vasodialation, vessel wall stiffness, muscle sympathetic nerve activity [MSNA], central sympathetic drive, nerve traffic, or combinations thereof with the device.~~

~~75. The method for treating a neural body in accordance with claim 74, wherein the monitoring is used to determine the bolus of energy and/or substance application.~~

~~76. The method for treating a neural body in accordance with one of claims 74 or 75, wherein the threading and/or termination of the threading is dependent upon the monitoring.~~

~~77. An infusion set or sheath introducer for measuring electrophysiological activity within the vicinity of a lumen comprising:~~

~~a cannula comprising a lumen through which a fluid and/or a surgical tool may be passed, comprising a distal tip and a control end, the distal tip thereof shaped and dimensioned so as to fit within the lumen, the cannula shaped and dimensioned so as to extend from an entry site on the body into the lumen; and~~

~~one or more probes configured with a tip, the probes deploy-ably coupled with the distal tip of the cannula, electrically, mechanically, and/or fluidly coupled to the control end of the elongate member, the tip of the probe shaped so as to penetrate into and/or through a wall of the lumen upon deployment from the cannula, one or more of the probes comprising one or more electrodes, electrically coupled to the probe, one or more of the electrodes configured to convey a signal associated with the electrophysiological activity upon deployment.~~

~~78. The infusion set or sheath introducer in accordance with claim 77, wherein the electrophysiological signals are related to one or more of water concentration, tone, evoked potential, remote stimulation of nervous activity, an electromyographic signal [EMG], a mechanomyographic signal [MMG], a local field potential, an electroacoustic~~

~~event, vasodialation, vessel wall stiffness, muscle sympathetic nerve activity (MSNA), central sympathetic drive, tissue tone, nerve traffic, or combinations thereof.~~

~~79. The infusion set or sheath introducer in accordance with claim 77 or 78, wherein the probe comprises an anchor for securing it to the wall of the lumen upon deployment, and the cannula is configured for post deployment removal from the lumen, leaving the probe in place.~~