nephron loss, cardiac dysfunction and heart failure due to left ventricular hypertrophy and myocyte loss, stroke, and even diabetes. Therefore, modulation (reduction/removal) of this increased sympathetic activity can slow or prevent the progression of these diseases.

[0001] Although ablation of such nerves can have positive effects on drug resistant hypertension and glucose metabolism abnormality, current methodologies for denervation (e.g. ablation) are conducted without adequate feedback (with respect to the site of a denervation event, the extent of denervation, the effect of denervation on local physiology, etc.).

SUMMARY

[0002] One objective of this disclosure is to provide a microsurgical tool for monitoring, evaluating, mapping, and/or modulating electrophysiological activity in the vicinity of an organ or a vessel within a body. Another objective is to provide a system and method for evaluating the sympathetic tone of a subject. Yet another objective is to provide a system for neuromodulating an anatomical site in the vicinity of an organ or vessel within a body. Another objective is to provide an implantable device for monitoring and/or performing a neuromodulation procedure.

[0003] 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.

[0004] According to a first aspect there is provided, a microsurgical tool for monitoring electrophysiological activity within the vicinity of an organ within a body, the microsurgical tool including an endoscopically deliverable elongate structure configured so as to extend from an entry site within the body to the vicinity of the organ; and at least one sensing tip electrically and mechanically coupled to the elongate structure, the at least one sensing tip being configured: to interface with tissues in the vicinity of the organ; to measure local neural activity associated with the tissues in the vicinity of the organ and to convey one or more electrophysiological signals associated with the local neural activity; wherein the at least one sensing tip comprises a clamp structure having an

inner surface configured to interface with the tissues in the vicinity of the organ and an outer surface opposite the inner surface; and wherein the at least one sensing tip comprises: a plurality of electrodes arranged on the inner surface of the clamp, the plurality of electrodes comprising one or more sensing electrodes configured to measure the local neural activity associated with the tissues in the vicinity of the organ; andone or more additional electrodes arranged on the outer surface of the clamp, the one or more additional electrodes arranged on the outer surface of the clamp being configured to determine a reference signal used by the at least one sensing tip to cancel out ambient environmental action potentials and noise from measurements of the local neural activity by the one or more sensing electrodes on the inner surface of the clamp.

[0005] In aspects, the electrophysiological signals may be related to one or more of water concentration, tissue tone, evoked potential, remotely stimulated nervous activity,

WHAT IS CLAIMED IS:

1. A microsurgical tool for monitoring electrophysiological activity within the vicinity of an organ within a body, the microsurgical tool comprising:

- an endoscopically deliverable elongate structure configured so as to extend from an entry site within the body to the vicinity of the organ; and
- at least one sensing tip electrically and mechanically coupled to the elongate structure, the at least one sensing tip being configured:

to interface with tissues in the vicinity of the organ;

to measure local neural activity associated with the tissues in the vicinity of the organ; and

to convey one or more electrophysiological signals associated with the local neural activity,

wherein the at least one sensing tip comprises a clamp structure having an inner surface configured to interface with the tissues in the vicinity of the organ and an outer surface opposite the inner surface; and

wherein the at least one sensing tip comprises:

a plurality of electrodes arranged on the inner surface of the clamp, the plurality of electrodes comprising one or more sensing electrodes configured to measure the local neural activity associated with the tissues in the vicinity of the organ; and

one or more additional electrodes arranged on the outer surface of the clamp, the one or more additional electrodes arranged on the outer surface of the clamp being configured to determine a reference signal used by the at least one sensing tip to cancel out ambient environmental action potentials and noise from measurements of the local neural activity by the one or more sensing electrodes on the inner surface of the clamp.

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, vessel wall stiffness, muscle sympathetic nerve activity [MSNA], central sympathetic drive, nerve traffic, or combinations thereof.

3. The microsurgical tool in accordance with claim any preceding claim, wherein at least one of the plurality of electrodes arranged on the inner surface of the clamp comprises at least one of an embossed, a plated, and a filament loaded structure thereupon.

4. The microsurgical tool in accordance with any preceding claim, wherein the at least one sensing tip is electrically coupled with a microcircuit, the microcircuit configured to condition the signal.

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

6. The microsurgical tool in accordance with claim 5, wherein the microcircuit is embedded into at least one of the at least one sensing tip and the elongate structure.

7. The microsurgical tool in accordance with any preceding claim, whereinat least one of the plurality of electrodes arranged on the inner surface of the clamp comprises at least one of one or more needle electrodes and one or more whiskers, each having a characteristic length and a tip and being arranged so as to extend from the at least one sensing tip into the tissues adjacent thereto.

8. The microsurgical tool in accordance with claim 7, wherein one or more of the needle electrodes and/or the whiskers comprise electrical insulation along the length thereof and electrically exposed tips.

9. The microsurgical tool in accordance with any preceding claim, wherein at least one of the plurality of electrodes arranged on the inner surface of the clamp comprises a microelectrode configured to interface with the adjacent tissues, the microelectrode having an area of less than 5000squm, less than 1000squm, less than 250squm, or less than 100squm.

10. The microsurgical tool in accordance with any preceding claim, wherein: the plurality of electrodes arranged on the inner surface of the clamp further comprise a plurality of

stimulating electrodes electrically and mechanically coupled to the elongate structure, the plurality of stimulating electrodes configured to provide at least one of a stimulating current an an ablating current to the adjacent tissues.

11. The microsurgical tool in accordance with claim 10, wherein the microsurgical tool is configured to control the stimulating and ablating currents between two or more of the stimulating electrodes via the adjacent tissues.

12. The microsurgical tool in accordance with claim 10 or 11, wherein the at least one sensing tip is configured so as to monitor the effect of the stimulating and ablating currents on the adjacent tissues and/or tissues related thereto.

13. The microsurgical tool in accordance with any one of claims 10 - 12, wherein the stimulating electrodes have an area of greater than 0.1sqmm.

14. The microsurgical tool in accordance with any preceding claim, further comprising means for delivering a therapeutic substance to the adjacent tissues.

15. The microsurgical tool in accordance with claim 14, wherein the at least one sensing tip is configured to monitor the effect of the therapeutic substance on the adjacent tissues or tissues related thereto.

16. The microsurgical tool in accordance with claim 14 or 15, wherein the 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.

17. The microsurgical tool in accordance with any one of claims 14 - 16, 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.

18. The microsurgical tool in accordance with any one of claims 14 - 17, wherein the therapeutic substance is comprised within a restraining matrix.

19. The microsurgical tool in accordance with claim 18, wherein the restraining matrix is at least partially biodegradable.

20. The microsurgical tool in accordance with any preceding claim, wherein at least one of the one or more additional electrodes on the outer surface of the clamp is coupled to a reference potential to shield the one or more sensing electrodes on the inner surface of the clamp.

21. The microsurgical tool in accordance with any preceding claim, wherein at least one of the one or more additional electrodes on the outer surface of the clamp is coupled to a reference potential to provide a stable reference against which to measure the local neural activity.

22. The microsurgical tool in accordance with any preceding claim, wherein the clamp structure comprises:

an arm;

a hinge;

a first clamp member having the inner surface and the outer surface; and

a second clamp member having the inner surface and the outer surface;

wherein the hinge couples the arm, the first clamp member and the second clamp member; and

wherein the hinge is configured to open and close the first clamp member and the second clamp member about the tissues in the vicinity of the organ.

23. The microsurgical tool in accordance with any preceding claim, wherein the plurality of electrodes arrange on the inner surface of the clamp further comprise one or more stimulating electrodes configured to apply ablation currents to the tissues in the vicinity of the organ.

24. The microsurgical tool in accordance with any preceding claim, wherein the clamp structure further comprises a local control circuit configured to perform pre-amplification, signal conditioning, radio frequency (RF) signal routing, analog to digital conversion, signal buffering, signal isolation, multiplexing/demultiplexing functions, and communication with externally located hardware.

25. The microsurgical tool in accordance with any preceding claim, wherein the clamp structure comprises a self-wrapping tool comprising one or more actuator layers, each of the one or more actuator layers comprising an active material configured to change shape upon command.

26. The microsurgical tool in accordance with claim 136, wherein the active material comprises one or more of a shape memory material, an electroactive polymer and a piezoceramic material.