Feb 15, 2022

Vagus Nerve Selective Stimulation and EIT recording

Enrico Ravagli[1], Svetlana Mastitskaya[1], Nicole Thompson[1], Kirill Aristovich[1], David Holder[1]

[1]University College London, University of London

1

dx.doi.org/10.17504/protocols.io.b42zqyf6

Enrico Ravagli

This electrophysiology protocol describes the electrical stimulation and measurement steps needed to localize branches and image functional activity in the cervical; vagus nerve of pigs.

DOI

dx.doi.org/10.17504/protocols.io.b42zqyf6

Enrico Ravagli, Svetlana Mastitskaya, Nicole Thompson, Kirill Aristovich, David Holder 2022. Vagus Nerve Selective Stimulation and EIT recording. **protocols.io** https://dx.doi.org/10.17504/protocols.io.b42zqyf6

SPARC
Grant ID: OT2OD026545

Neuromodulation, Electrical Impedance Tomography, Vagus Nerve

protocol ,

Feb 14, 2022

Feb 15, 2022

58169

ScouseTom EIT System: https://doi.org/10.3390/s17020280

EIT/SS nerve cuffs: https://github.com/EIT-team/Electrode-Designs/tree/master/Enrico_Pigs_SS_EIT_Jan2021

Cuff manufacturing process: https://doi.org/10.1088/1741-2552/aae868

Laptop or PC, Matlab software

Animal surgery facility, physiological readout system with End-Tidal CO2, Blood Pressure, and ECG capabilities.

EMG needles and bipolar stimulation cuff for larynx.

Preparation

1 Animal (pig) is anaesthetized (Isofluorane) and cervical vagus is exposed through surgery.

2 Clean electrodes of the nerve cuffs by dipping into ethanol and then physiological solution (or saline solution).

3 Apply nerve cuffs to exposed cervical left vagus and connect to the ScouseTom system.

4 Apply other required electrical interfaces: EMG needles on larynx, bipolar stimulation cuff on recurrent laryngeal branch (approx. 40cm from cervical vagus cuffs).

Selective Stimulation - Pulmonary Branch

5 Set initial parameters for selective stimulation of the pulmonary branch: suggested 50μs pulse width, 0.4mA pulse amplitude, 20Hz repetition frequency, 30s on / 30s off stimulation. Set animal ventilation setup to spontaneous breathing.

6 Run selective stimulation with above parameters and observe ETCO2 response to stimulation (breathing slowdown or complete block) on different electrode pairs.

7 Repeat stimulation rounds with increased or decreased pulse amplitude until ETCO2 alteration is localised to one or a few stimulation pairs. Restore mechanical ventilation after completion.

Citation: Enrico Ravagli, Svetlana Mastitskaya, Nicole Thompson, Kirill Aristovich, David Holder Vagus Nerve Selective Stimulation and EIT recording https://dx.doi.org/10.17504/protocols.io.b42zqyf6

Selective Stimulation - Recurrent Laryngeal Branch

8 Set initial parameters for selective stimulation of the recurrent laryngeal branch: suggested 50μs pulse width, 50-100μA pulse amplitude, 20Hz repetition frequency, 5s on / 5s off stimulation. Animal can stay in mechanical ventilation during this phase.

9 Run selective stimulation with above parameters and observe EMG needle response to stimulation (activation of larynx shows bursts of activity on EMG recordings) on different electrode pairs.

10 Repeat stimulation rounds with increased or decreased pulse amplitude until EMG bursts in response to stimulation are localised to just one or a few stimulation pairs.

Laryngeal EIT

11 Connect stimulator output of ScouseTom to bipolar cuff placed on laryngeal branch. Connect ScouseTom in EIT mode to vagus nerve EIT cuff.

12 Perform evoked fast neural EIT according to published work with following parameters:
- EIT: skip-5 pattern, 200 μA, 6kHz, 15s each injection pair
- Stimulation: 50 μs pulse width, 1.2 mA amplitude, 20 Hz repetition during each injection

Selective Stimulation - Cardiac Branch

13 Switch anaesthetic from isofluorane to α-chloralose and wait 30-40 minutes for settling.

14 Set initial parameters for selective stimulation of the recurrent laryngeal branch: suggested 1ms pulse width, 1mA pulse amplitude, 20Hz repetition frequency, 30s on / 30s off stimulation. Animal can stay in mechanical ventilation during this phase.

15 Run selective stimulation with above parameters and observe heart rate response to stimulation, computed in real time from peaks in blood pressure or ECG on different electrode pairs.

16 Repeat stimulation rounds with increased or decreased pulse amplitude until heart rate change in response to stimulation is localised to just one or a few stimulation pairs.

Spontaneous EIT

17 Perform spontaneous fast neural EIT with following parameters:
- No stimulation

Citation: Enrico Ravagli, Svetlana Mastitskaya, Nicole Thompson, Kirill Aristovich, David Holder Vagus Nerve Selective Stimulation and EIT recording https://dx.doi.org/10.17504/protocols.io.b42zqyf6

- EIT: skip-5 pattern, 200 µA, 6kHz, 10 minutes each injection pair
- Recording ECG, blood pressure, End-Tidal CO_2 on auxiliary channels of the recording system

Citation: Enrico Ravagli, Svetlana Mastitskaya, Nicole Thompson, Kirill Aristovich, David Holder Vagus Nerve Selective Stimulation and EIT recording https://dx.doi.org/10.17504/protocols.io.b42zqyf6