Implantable telemetry devices to record seizures and cortical spreading depression in freely moving rodents.

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Previous reports on seizures and CSD in the same tissue are restricted to sparse electrical recordings, often in the setting of other pathologies, and have not resolved how the two phenomena relate to one another.

A major limiting factor was the absence of experimental tools that would allow one to perform concurrent recordings of both seizures and CSD in an awake animal.

 We are developing 3 novel approaches: *in viv*o Ca2+ imaging, implantable transmitters for continuous recording in freely moving rodents and grids of graphene based transistor arrays that allow us to record both seizures and CSD simultaneously.

Here we describe the implantable telemetry devices.

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Novel Transmitters DC-160Hz

Novel transmitter broadcasts two channels at 512 Hz, low-passed at 160 Hz and without a high-pass filter. This allows CSD and seizures to be simultaneously recorded from two sites.



Acute injection of KCI via a preimplanted cannula over visual





Distance between VC and MC craniotomies = 3.5 mm

Mouse under low isoflurane – 0.5%

High cortical spreading depression susceptibility and migraine-associated symptoms in Ca(v)2.1 S218L mice.

Mice have CSD reduced triggering threshold, an increased propagation velocity, and frequently multiple CSD events after a single stimulus (van den Maagdenburg AM et al 2010).



1 min

Recording electrodes in the ipsilateral motor and visual cortex of wild type (WT, top traces) or *Cacna1a*S218L/WT (HET S281L) 6 week-old mice. Reference electrodes in the contralateral cerebellum. The distance between the motor and visual cortex electrodes was ~ 3.5 mm, giving estimated propagation velocity ~ 4 mm/min in WT and ~ 6 mm/min in S218L HET mice.



T155/T156 M1513941460_2100-2580



T155/T156 M1513623553_1700-2180



T155/T156 M1513418352_1000-1480



T155/T156 M1513443552_2900-3380



T155/T156 M1513461552_3400-280



T165/T166 M1513396752_3500

Different mouse

Seizure from migraine mouse (218L KI HET) recorded using a regular transmitter. 0.3-160Hz



- Regular transmitter 1mV = 2427 point range
 - DC transmitter 1mV = 250 point range.
- Is 250 points/mV good enough to record epileptiform activity?

Epileptiform activity recorded with DC-160Hz transmitter



200nl 10mM PTX injected Layer 5 visual cortex via the cannula.

218L Mouse - HET

CSD recorded in a HET 218L KI Mouse following Picrotoxin induced spiking.



CSD following a Picrotoxin –induced seizure



M1514121010 - 840-1440 T165 & 166. PTX VC HET S218L male mouse.



218L mouse 200nl PTX visual cortex

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C57BL/6J mouse injected with TeNT into the visual cortex. CSD recorded post spontaneous epileptiform activity.





T151-T152 M1527097297_1000-1500 recorded 8 days post injection of TeNT C57BL/6J mouse injected with TeNT into the visual cortex. CSD recorded post spontaneous epileptiform activity.



recorded 7 days post injection of TeNT



Drift and artefacts



2 sequential 1hr recordings. Top trace shows a spontaneous CSD, bottom trace shows electrode drift.



Examples of artefacts -1hr long traces.







M151178277_822-1020 218L KI mouse - HET



M1511797196_452-752 218L KI mouse - HET



218L KI mouse - HET