Detection of Striatal Dopamine Release using a Turn-Key Fast Scan Cyclic Voltammetry System and Fixed Potential Amperometry

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Introduction

Fixed Potential Amperometry (FPA) is a general technique which measures all compounds oxidizing on an electrode tip held at a constant potential (0.6 V).

Continuous Fast Scan Cyclic Voltammetry (FSCV) measures biogenic amine signatures by rapidly cycling the voltage on an implanted carbon fiber sensor (CFS) and recording the amperometric change resulting from specific oxidation and reduction events.

Previous studies have used one recording technique (FSCV) or FPA for the detection of dopaminergic activity within the striatum.

We have developed turn-key wired and wireless systems that include a 34 µm carbon fiber sensor, hardware and software to continuously record FSCV data from both anesthetized and freely moving rodents. We have used the same 34 µm carbon fiber sensor design with our fixed potential electronics to record continuous FPA data from both freely moving and anesthetized animals.

The purpose of this effort is twofold. To demonstrate the efficacy of these systems for the measurement of biogenic amines in freely moving rats and mice, and to show that, with contralateral electrode placement, FPA and FSCV can be simultaneously measured in a rat, and finally, to look for correlations between the techniques when they are employed in this manner.

Methods

Freely Moving

Young (age 2-3 months) C57Bl6 mice or young (age 3-4 months) Sprague Dawley rats were surgically implanted with a carbon fiber electrode placed in the striatum. A single Ag/AgCl reference electrode was implanted in the contralateral cortex region.

All animals were housed under a 12 hour light 12 hour dark cycle persisting throughout the experiment with food and water available ad lib. All surgical procedures were done under a University of Kansas ACUC approved protocol.

Mice were connected to a lightweight tether and afferent stimulation (Figure 1a). All rats were fitted with a plastic recording enclosure designed to fit on the head of the animal and protect the electronics, carbon fiber sensor and reference electrode (Figure 1b).

After a one week recovery period, the carbon fiber sensor and reference electrode were connected to Pinnacle’s I504 tethered FSCV system (more, Figure 1a) or Pinnacle’s 8501 wireless FSCV system (rats, Figure 1b). In some animals, either an electrical stimulus was applied or an amphetamine bolus was administered to enhance biogenic amine release. Dopamine (DA) was detected with continuous FSCV using voltages ranging from -0.4 V to 1.1 V at a sweep rate of 1000 V/s. The resulting oxidation and reduction peaks were recorded using the PAL 8500 software suite.

Dual Implantation

Two 34 µF CFS’s were implanted contralaterally within the striatum of an anesthetized Sprague Dawley rat (AP: +1.5 M; ML: +/- 2:0.DV: -5.5 mm). Separate Ag/AgCl references for each recording electrode were placed in the anterior cortex. A stimulating electrode was implanted in the medial forebrain bundle region (AP: -3.6 M; ML: +0.8, Depth: -7.5 mm) (Figure 2). The stimulating electrode was used to confirm FSCV sensor placement. An amphetamine bolus (8 mg/kg) was administered and responses were recorded continuously from both the FSCV sensor and the FPA sensor in the same animal.

Results

Collection of FSCV waveforms may be successfully accomplished in anesthetized and freely moving mice and rats with or without use of a stimulating electrode.

The ability to simultaneously measure FPA and FSCV in the same animal lead to new insights into the efficacy of both techniques in the measurement of biogenic amines.

This experimental technique also opens the possibility of using FSCV and biosensors in simultaneous, contralateral measurements.

References


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