

Implantable Wireless System for Monitoring the Change in Functional Behavior of Rats – A Proof of Concept Study

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Technical Abstract:

Introduction: There is a need for improved functional testing of laboratory animals with high throughput. In particular, diseases such as stroke need to assess laterality of function. We have conducted studies with a wireless and implantable system to demonstrate proof-of-concept for a suitable micro electro mechanical system (MEMS).

Methods: The system consists of a MICA2DOT mote (Crossbow Technology) with 6 analog input channels, a TL-5934 3.6 V 1000 mAh battery (Tadiran), and two ADXL330 three axis accelerometers (Analog Devices). The battery and mote are packaged together and sealed in plastic. The total weight of the package is 20.5 grams. The mote is implanted at the back of the rat, and the accelerometers are implanted in the rat's front paws. Five wires from either accelerometer are tunneled under the skin to the mote. The mote wirelessly streams data to the base station (Crossbow Technology), connected to a computer running MoteView for data collection and management. The mote and base station run the Crossbow Technology programmed TinyOS application, which allows for a maximum streaming rate of 0.3 seconds. The system has a battery lifetime of 3 days. The changes in function were measured in rats with two models: 1) ischemic stroke by middle cerebral artery occlusion (MCAO) 1-hour occlusion and 2) Amphetamine 3 mg/kg i.p. Data was collected for 3 days. For each limb, the root mean square (RMS) was calculate from each of the three channels of an accelerometer and summed. The mean RMS over 10 minutes epochs were compared between limbs and over time.

Results: For normal behavior, the RMS ranged from 0.16 V to 0.22 V for either side. After stroke, the RMS ranged from 0.26 V to 0.32 V for the right side (unaffected by MCAO) and 0.08 V to 0.12 V for left side (affected by MCAO). There was no difference between limb activity before stroke and a significant decrease in left limb compared to the right ($p < .001$, *t-test*). For the amphetamine case the values fluctuates significantly more and fall in the range of 0.04 V to 0.34 V for both sides. There was no difference in RMS between limbs or after amphetamine however the variance was significantly larger after amphetamine delivered ($p < 0.0001$, Bartlett's test).

Conclusion: We have demonstrated a wireless and implantable system for monitoring the changes in basic functional behavior in rats. Our preliminary results suggest that changes in activity as well as laterality can be addressed using this system.