Implantation Protocol for Polymer MEAs (PIE Standard MEA) in Rat Brain

Equipment:

- Surgical table
- Microscope
- Stereotaxic frame with micromanipulators
- Dental drill
- Heating pad and thermometer
- Cautery pen

Surgical Tools:

- Hemostat forceps x 6
- Scissor x 1
- Scalpel handle and scalpel x 1
- Fine tip tweezer x 2
- Mixing bowl

Implants:

- Multi-shank polymer MEAs
- Anchor screws x 3 to 5

Materials:

- Iodine or Iodine pad
- 70% ethanol or ethanol pad
- Eye ointment
- Kim wipes
- Cotton-tipped applicators
- Cotton
- Saline
- Bacitracin Zinc Ointment
- Dura-Gel
- Rectal thermometer cover

Anesthesia and Analgesia:

- Isoflurane
- BUP SR

Preparation:

1. Autoclave all surgical tools
2. Sterilize all working area with 70% ethanol

Animal Preparation:

1. Anesthetize the rat with 4% isoflurane in induction chamber
2. Fix the animal on the stereotaxic frame with ear bars
3. Maintain anesthesia with 1% - 2% isoflurane (reflex response checked every 15 mins throughout the surgery, adjust isoflurane concentration accordingly)
4. Shave the hair on scalp
5. Apply eye ointment to both eyes
6. Disinfect the scalp with Iodine and 70% ethanol
7. Insert the rectal thermometer and turn on the heating pad
8. Inject BUP SR (1 mg/kg, subcutaneous)

Craniotomy:

1. Make an incision alone the midline of the scalp, expose the entire skull (5mm anterior to the bregma, 5 mm posterior to the lambda, left and right side to the skull ridge)
2. Remove periosteum with scalpel and tweezers
3. Clean the skull surface with cotton-tip applicator and saline, stop bleeding on the muscle using the cautery pen
4. Drill three to five burr holes for anchor screws (Fig. 1), leave enough space between holes for anchor screws, drill one small burr hole above the cerebellum for ground wires
5. Adjust the animal's head, make the bregma and the lambda at the same plane
6. Move the micromanipulator to the bregma and set it as the zero point
7. Make four marks to define the skull window (AP: 1.5mm, ML: 2mm; AP: 1.5mm, ML:4mm; AP: 5.5mm, ML:2mm; AP: 5.5mm, ML: 4mm)
8. Use drill and tweezers remove the skull in marked region, apply some saline to cool the skull and remove bone dusts

Polymer MEA Implantation:

1. Gently remove the dura layer with tweezer, apply saline to keep the craniotomy moisturized
2. Attached the polymer MEA to the micromanipulator and align the bottom tip of the first shank with the bregma
3. Put all anchor screws into burr holes
4. Move the polymer MEA to desired location (AP: 2.5mm, ML: 2.45mm)
5. Carefully make an incision on the pia layer, apply saline to rinse away blood and lightly press a small, soaked cotton ball on the brain surface for 5 mins to stop the blood (if needed, press the cotton ball for longer)
6. Lower down the polymer MEA with the micromanipulator and insert the MEA to desired depth (~ 4.20mm for the rat hippocampus) at a speed around 0.5mm/sec. Insert the ground wire into the burr hole above the cerebellum
7. If the MEA is connected to any recording system, fine adjust (50 μm/time) the depth of the MEA according to neural signals. More spike activities with high signal-to-noise ratios on majority of recording channels are preferred

MEA Fixation:

1. Apply saline to dissolve all PEG coating on the MEA
2. Dry the craniotomy with sterilized kim wipes and wait 10 mins to let the surface of the MEA dry
3. Mix 1 ml of Dura-Gel and apply a thin layer of Dura-Gel to the craniotomy, make sure all polymer shanks are embedded in Dura-Gel
4. Let the Dura-Gel set for 5 mins then apply a layer of dental cement to cover the craniotomy, anchor screws and burr holes for ground wires, wait for the dental cement get fully dried
5. Slowly lower down the PCB (bend the ribbon cable part of the polymer MEA, 90 degree at most) if needed
6. Apply enough dental cement to cover the ribbon cable and half of the PCB, add additional dental cement to form a solid cap around the PCB
7. Suture the skin if needed
8. Apply Bacitracin Zinc Ointment on the skin

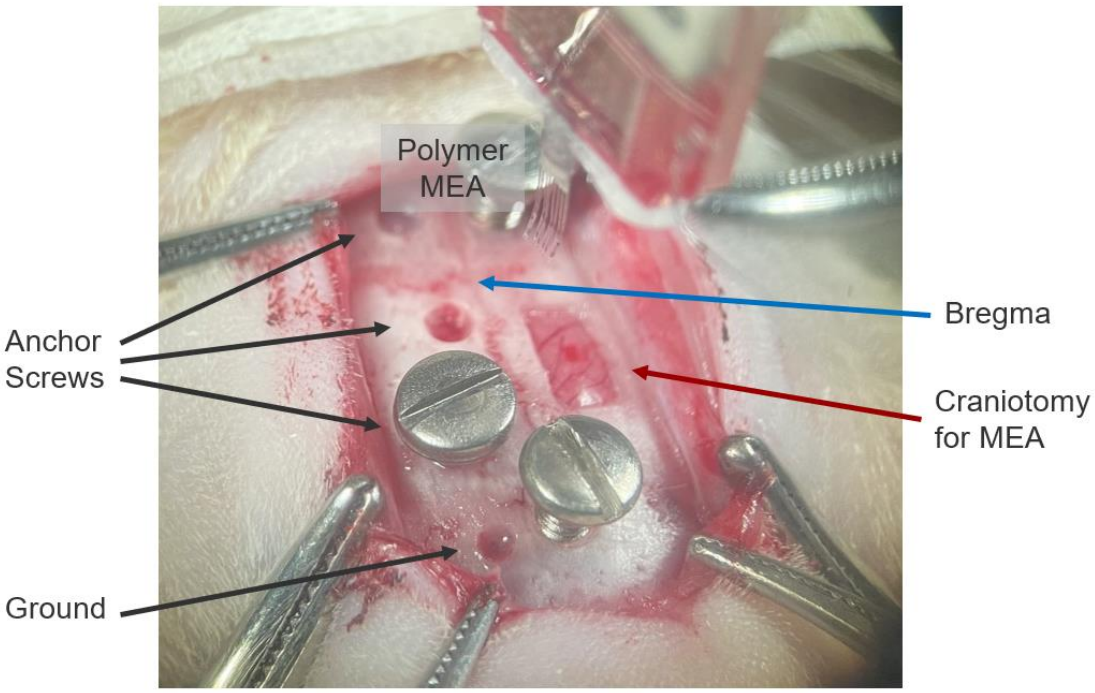

Fig 1. Typical location of five anchor screws, burr hole for ground wire and craniotomy for the polymer MEA.