Electrode Surgical Implantation Protocol

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Contents

Introduction

Disclaimer: *These protocols are intended as a guide for familiarization with the device and system. Surgical and animal welfare guidelines vary by institution. Please consult your institution's veterinary professional to ensure compliance with local regulations and protocols.*

Purpose: *This procedure specifically details the surgical implantation of electrodes for EEG and EMG recordings in mice and rats using either our SCT or HMT devices. This protocol does not cover the complete surgical procedure for transmitter implantation.*

Related Protocols

- Electrode Implantation
- Subcutaneous Transmitter Implantation
- Head-Mounted Transmitter Implantation
- X-Electrode Crimp Contact Tutorial (Video)
- J-Electrode Implantation (Visual Guide)
- Silicone Removal Guide

Depth Electrodes

Our Depth Electrodes allow for a deeper reach into the brain. The insulated wire in the electrode will bve delivered either in the standard length or in a length specified by the you. You can cute the wire back to any length yourseld, either with a square cut or at an angle for better penetration. Each electrode provides a mounting fixture by which we can hold the electrode during surgery.

J-Electrode

Figure: J-Electrode

Materials Required

- J-Electrode
- Lead with D-Pin
- Vetbond (biocompatible cyanoacrylate adhesive)
- Dental cement
- Stereotaxic apparatus with attachment to hold the metal electrode tube

Directions

- Trim the insulated electrode wire to the desired length, based on the recording depth.
- Secure the J-Electrode by its cannula guide in a clamp above the animal's head, mounted to a stereotaxic instrument for steady insertion.
- Connect the D-Pin lead to the electrode socket.
- Lower the electrode into the burr hole to the target depth.
- Seal the socket and burr hole with Vetbond adhesive followed by dental cement, or with cement alone. Avoid covering the cannula.
- After the cement cures, cut the bare steel wire where it emerges from the cannula pedestal.
- Lift the cannula off the wire.
- Cut the wire flush with the cement surface and cover the exposed tip with additional cement.

R-Electrode

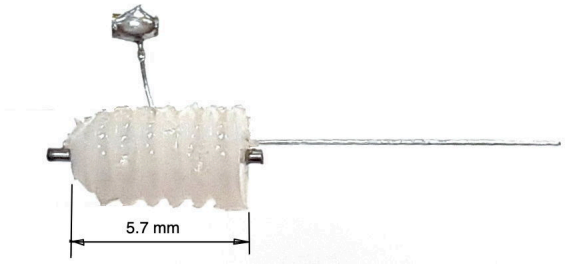


Figure: R-Electrode

Note: *The R-Electrode is designed to allow repetead substance into the animals brain. The guide cannula remains on the animals head throughout the experiment.*

Materials Required

- R-Electrode with dummy cannula
- Vetbond (biocompatible cyanoacrylate adhesive)
- Dental cement
- Stereotaxic apparatus with attachment to hold the metal electrode tube

Directions

1. The R-Electrode includes both a cannula for injections and a depth electrode wire. Drill a burr hole large enough for both components.
2. Trim the insulated electrode wire to the desired length. Optionally, cut at an angle for easier penetration.
3. Secure the R-Electrode by its cannula guide in a stereotaxic clamp above the animal's head.
4. Connect the D-Pin lead to the E-Socket using tweezers. Customized orientations are available upon request.
5. Check the connection by gently tugging near the socket-pin junction.
6. Lower the electrode and cannula into the burr hole.
7. Cover the base of the electrode and the burr hole with dental cement.
8. Attach the dummy cap to the R-Electrode when not injecting.

W-Electrode

Figure: W-Electrode

Materials Required

- W-Electrode
- Subcutaneous Lead with D-Pin termination
- Vetbond (biocompatible cyanoacrylate adhesive)
- Dental cement
- Stereotaxic apparatus with attachment to hold the metal electrode tube

Directions

1. Trim the insulated electrode wire to the target length. Optionally, cut the tip at an angle for easier penetration.
2. Note: The W-Electrode has a post that must be cut above the socket and pin connection after implantation. Practice beforehand to reduce shaking.
3. Secure the W-Electrode by its cannula guide in a stereotaxic clamp above the head.
4. Insert the D-Pin lead into the E-Socket on the W-Electrode.
5. Confirm the crimp contact is secure by gently pulling the lead.
6. Lower the electrode into the burr hole to the desired depth.
7. Cut the metal post carefully at the thinned section above the socket.
8. Cover the electrode and socket area with dental cement.

X-Electrode

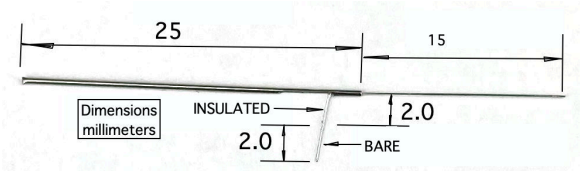


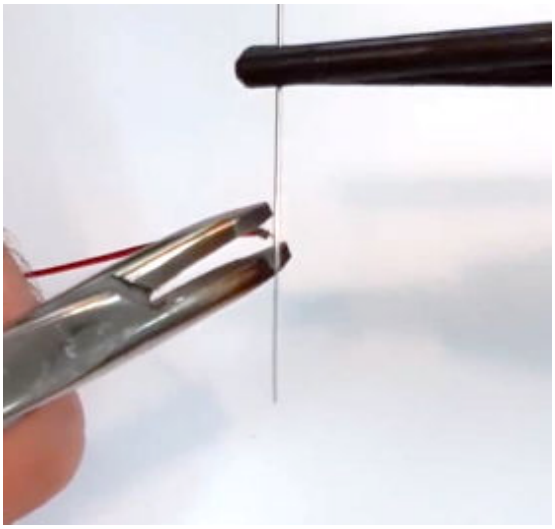
Figure: X-Electrode

Materials Required

- X-Electrode
- B-lead with 1.5–3 mm exposed stainless steel spring (425 µm OD), stripped of silicone
- Q-ferrule
- Crimping tool (grooved needle-nose pliers recommended)
- Vetbond (biocompatible cyanoacrylate adhesive)
- Dental cement
- Stereotaxic apparatus with attachment to hold the metal electrode tube

Directions

1. Trim the insulated electrode wire to the target length. Optionally, cut the tip at an angle for penetration.
2. The X-Electrode has a post that must be cut after implantation. Practice the cut beforehand to avoid shaking.
3. Secure the X-Electrode in a stereotaxic clamp above the head.
4. If the B-lead is unstripped, expose 1.5–3 mm of coil at the tip (3 mm preferred). See Lead Stripping for guidance.
5. Hold the B-lead ~5 mm from the coil and slide the Q-ferrule on, keeping it near the X-Electrode.
6. Ensure ~4 mm of stripped X-Electrode wire is available for the crimp.
7. Guide the coil and Q-ferrule over the X-Electrode wire so the wire passes through the coil center.
8. Position the ferrule to overlap both coil and stripped wire.



Video: X-Electrode and B-Lead Crimp Connection with Q-Ferrule.

9. Crimp firmly with pliers to secure.
10. Test the crimp by gently pulling the lead.
11. Cover the electrode and socket with dental cement (optionally add Vetbond adhesive first).
12. Cut the X-Electrode post at the thinned section and seal any exposed metal with cement.

Surface Electrodes

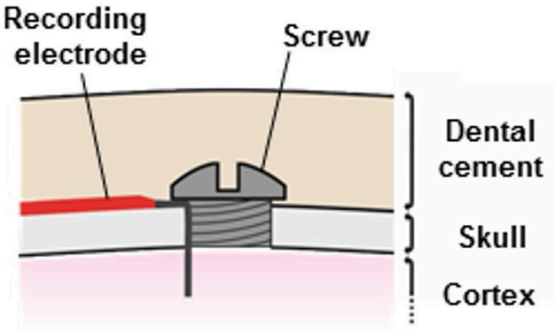


Figure: Angled Wire Electrode, held in place by a fastening screw.

Coiled Wire

Note: *Coiled wire electrode use a helical bare wire tip. Straighten them prior to implantation.*

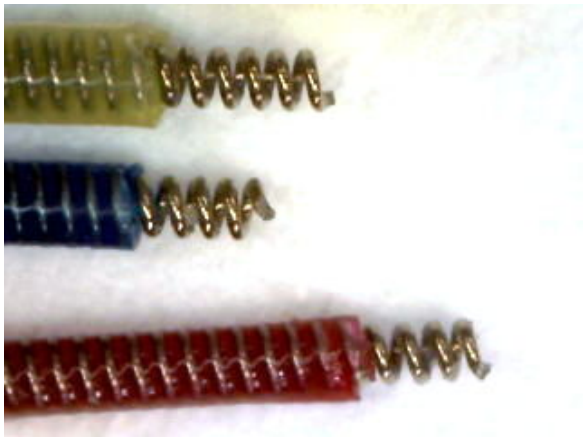


Figure: A-Coil wire termination at the end of a B-Lead

Materials

- Subcutaneous lead with coil termination>
- Fastening screws
- Vetbond (biocompatible cyanoacrylate adhesive)
- Dental cement
- Screwdriver

Directions

1. Straighten the bare coiled wire carefully with tweezers, avoiding tension on the lead.
2. Create a 90° bend at the midpoint of the bare wire.
3. Trim the bent section so it matches skull thickness plus desired cortical depth.
4. Test screw fit in burr holes; holes should be slightly smaller for a snug fit.
5. Insert the electrode into the burr hole, securing it with tweezers.
6. Leave a short section of exposed wire atop the skull (before the bend) to prevent screw contact with insulation.
7. Optionally apply semi-cured Vetbond to the wire on the skull (avoid the burr hole) to stabilize before screwing.
8. Insert the screw into the burr hole, ensuring the electrode does not bind in the threads.
9. Cover the screw and exposed wire with dental cement to insulate and reduce EEG artifacts.

Notes

- Ensure cement is fully dry before closure.
- Position screws several millimeters away from insulated lead sections.
- Screws must avoid muscle contact.

Straightened Wire

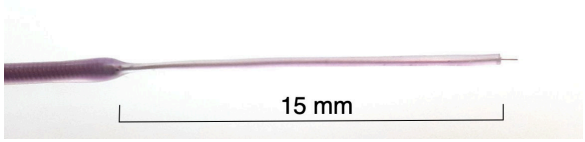


Figure: M-Wire termination at the end of a B-Lead

Materials

- Subcutaneous lead with M-Wire termination
- Fastening screws
- Vetbond adhesive
- Dental cement
- Screwdriver

Directions

1. Create a 90° bend halfway along the bare wire.
2. Trim the bent section to match skull thickness plus target depth.
3. Test screw fit in burr holes for snug engagement.
4. Insert the electrode into the burr hole while securing with tweezers.
5. Leave a small section of exposed wire atop the skull to isolate from the screw.
6. Optionally apply semi-cured Vetbond on the skull surface for stability, avoiding the burr hole.
7. Screw into the burr hole without trapping the electrode in threads.
8. Seal with dental cement to insulate and reduce artifacts.

Screw Electrodes

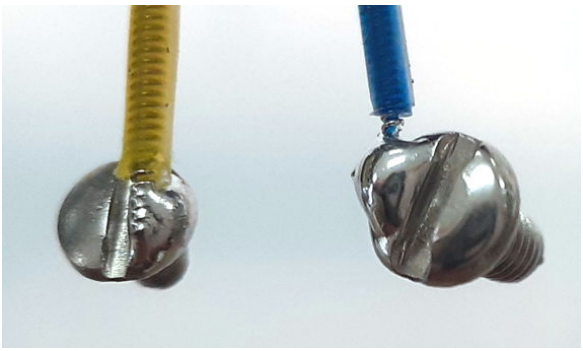


Figure: Screw Electrodes. Left: K-Screw. Right: B-Screw.

Materials

- Lead with stainless steel screw electrode
- Vetbond adhesive
- Dental cement
- Screwdriver

Directions

1. Verify screw fit in burr holes for a tight hold.
2. Screw the electrode into the burr hole, ensuring the wire remains free of threads.
3. Cover the screw and exposed wire with dental cement to insulate and minimize signal artifacts.

EMG Electrode Implantation Protocol

Materials

- Subcutaneous leads with P-coil termination (3–4 mm exposed wire at the tip)
- Pointed syringe needle (~23G for thinner C leads, ~20G for thicker B leads)
- Kwik-Cast biocompatible silicone sealant
- Sterile suture kit
- Dental cement

1. Device Preparation

1. Confirm the EMG lead (connected to the SCT) has 3–4 mm of exposed coil wire. Strip additional silicone if necessary (lead stripping video).
2. Verify the exposed coil fits through the selected syringe needle.
3. Sterilize all tools and materials before use.

2. Head Incision and Exposure

1. Use forceps and scissors to lift the scalp and remove a section to expose the skull.
2. For EMG, extend the head incision slightly beyond the skull to expose trapezius muscles—do not make a separate incision.
3. Expose both trapezius muscles for electrode placement.
4. Remove connective tissue from the skull and clean with diluted (6% v/v) hydrogen peroxide, then dry immediately. Remove residual tissue with a bone scraper.

3. Transmitter Device Implantation

1. **For SCT:** Follow the SCT Surgical Protocol to implant the transmitter and tunnel the leads before EMG placement. Ensure the EMG lead is pre-cut, stripped, and has adequate slack.
2. **For HMT:** Follow the HMT Surgical Protocol to attach the EIF connector and prepare EEG burr holes. Ensure the EMG lead is longer than EEG leads and positioned posteriorly for a direct muscle path.

8. EMG Electrode Placement

1. Identify the trapezius muscles at the skull base and locate the midline.
2. Use a syringe needle to create a ~2 mm horizontal tunnel through the trapezius, entering opposite the EMG lead.
3. The tunnel should be just deep enough to secure the electrode without superficial exposure.

4. Control any bleeding with sterile cotton.
5. Leave the needle in place.
6. Thread the stripped coiled wire (e.g., A-coil) through the needle tip until 1–2 mm exits on the muscle surface.

9. Securing the EMG Electrode

1. Ensure 1–2 mm of bare wire protrudes before removing the needle.
2. Remove the needle carefully, stabilizing the wire with tweezers.
3. Cap the exposed coil using the OSI-provided wire cap to insulate the electrode and reduce artifacts.
4. Optionally secure the cap with Kwik-Cast sealant, avoiding the tunnel interior.
5. Suture over the capped wire at the exit site to anchor it.
6. Suture the subcutaneous lead at the entry point for stability.
7. Optionally apply dental cement to the lead before muscle entry to limit movement (avoid excess cement).

7. Closing

1. Follow SCT or HMT closing protocols.
2. Ensure electrodes are secure and adhesives are fully cured.
3. Leave slack in the EMG lead to accommodate head and neck motion.
4. Close the incision by suturing up to the skull base.
5. Complete the dental cement cap procedure as per SCT or HMT protocols.

Notes and Best Practices

- When reusing SCT leads, re-strip the silicone cleanly (video guide).
- Avoid filling burr holes with Vetbond—particularly for depth electrodes, which do not fully occupy the hole.