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Surgery for Electrophysiological Recording in Behaving Non-Human Primates: Chamber and Head-Post Implantation

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We use this protocol and it's working

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Abstract

The initial step in conducting electrophysiological recordings from awake, head-restrained non-human primates involves surgical placement of head-posts and a recording chamber. When maintained properly and kept free of infection, these implants can remain viable for several years. However, infections, particularly at the interface between the implant and the skull, can lead to implant failure within just a few months. As such, maintaining strict sterility during surgical procedures is critical for the long-term success of the implant.

Materials

	Item	Specifications	Vendor	Note
	Bone Screw	2.7 mm Cortical Screw with 2.5 mm Head Recess, Hex, Titanium, 8 mm length, T270.08	Movora	https://movora.com/us/en/voi-2-7mm-cortical-screw-with-2-5mm-head-recess-non-self-tap-hex-titanium-t270-08
	Bone Screw	M3, 0.5 mm polycarbonate pan head Phillips screw; Head Diameter: 6 mm; Length: 6mm, 7mm, and 8mm	McMaster-Carr	https://www.mcmaster.com/products/polycarbonate-screws/drive-style~phillips/length~6-mm/length~8-mm/?s=polycarbonate-screws
	Chamber	Ovular shape, Major axis: 35 mm; Minor axis: 27 mm; Height: 22 mm	Custom-made	The chamber's shape and dimensions vary depending on the purpose of the experiment.
	Chamber Cap		Custom-made	
	Screws for a Chamber Cap		McMaster-Carr	
	Head fixation posts (2)	Length: 50 mm; OD: 14 mm; ID: 8 mm	Custom-made	
	Chamber holder bar		Custom-made	Secures the chamber in place and can be mounted onto the stereotaxic arm
	Head fixation post holder bar		Custom-made	Secures the head fixation posts in place and can be mounted onto the stereotaxic arm
	Dental Acrylic			
	Stereotaxic frame for NHPs		NA	
	Stereotaxic arms (2)		NA	
	Electric Drill			
	Drill Bit	40 gauge		

	Item	Specifications	Vendor	Note
	Hand Tap			
	Sterile Surgical Instruments			
	Suture			
	Hex driver	2.5 mm	McMaster-Carr	https://www.mcmaster.com/52975A16/
	Phillips head screwdriver			

Safety warnings

Warning

Ethics statement

This protocol requires prior approval from the users' Institutional Animal Care and Use Committee (IACUC) or an equivalent ethics committee. The authors obtained approval for this protocol from the IACUC at the University of Pittsburgh (Protocol #23091930).

Before start

This protocol requires prior approval from the users' Institutional Animal Care and Use Committee (IACUC) or an equivalent ethics committee.

Planning for the implantation of the head fixation post and recording chamber

1 Determine the coordinates of the brain area you are targeting relative to the ear bar zero using MRI.

2 Attach your chamber holder bar to the stereotaxic arm and mount the arm onto the stereotaxic frame for calibration.

3 Adjust the stereotaxic arm's position and angle so that the tip of the chamber holder points at the coordinates you determined in step 1.

4 Note down the positions of the stereotaxic arm and frame. The anterior-posterior coordinate on the rail of the stereotaxic frame, the medial-lateral coordinate on the arm, and the angle of the arm.

Preparation on the days leading up to the surgery

5 Submit an NPO (nothing by mouth) form for the animal scheduled to receive the implant.

6 Bring all necessary sterile tools to the surgical suite and set up the surgical suite.

Preparation on the day of the surgery in the prep room

7 Sedate the animal receiving the implant.

8 Shave the hair off of the animal's head.

9 Start the gas anesthesia.

10 Using a cart, transfer the sedated animal to the surgical suite.

Surgical procedure in the surgery suite

11 Fix the animal's head on the stereotaxic frame, making sure the head is completely secure and free of any movement.

12 Thoroughly wipe the surface of the animal's head with alcohol, then betadine.

13 Thoroughly wipe the surface of the rails of the stereotaxic frame with betadine.

14 Scrub in for surgery using proper sterile technique.

15 Enter the OR and don a sterile surgical gown.

16 Wear two pairs of sterile gloves. The double layer provides added protection against tears and injuries, and allows the surgeon to remove the outer pair if it becomes contaminated without the need to rescrub.

17 Cover the entirety of the animal's body, except for the head, with sterile surgical drapes. This will leave the surface of the head you cleaned in a previous step exposed.

18 Make an incision in the exposed skin and remove a round piece skin that is large enough to expose sufficient skull for constructing the implant.

19 Remove any underlying soft tissue from the surface of the skull.

20 Cut the sterile drape around the rail of the stereotaxic frame so that you are able to mount the base of the stereotaxic arm onto the rail.

21 Mount the base of the stereotaxic arm on the rail of the stereotaxic frame at your predetermined coordinate, trying your best not to touch the exposed rail.

22 Cover the exposed rail of the stereotaxic frame with a new sterile drape so that nothing unsterile is exposed.

23 Attach the main part of the stereotaxic arm to its base.

24 Mount the chamber and the head fixation posts onto the stereotaxic arms and position them as close to the skull as possible. Confirm that the skin opening size is sufficient and identify head post positions that do not contact the chamber.

25 Use a sterile marker to trace the outline of the chamber as well as the head fixation posts onto the skull.

26 Detach the main part of the stereotaxic arms and place them on a sterile surface somewhere out of the way.

27 Verify that the skin incision provides adequate skull exposure to build the dental acrylic implant, allowing at least 5 mm of space from the chamber edge to the implant edge. Ensure there is also sufficient space for head fixation post placement.

28 Separate the muscle from the skin and from the skull. If the muscle lies too close to where the implants will be placed, remove it using electrocautery.

29 Insert a drill bit into your drill, leaving 2.8-4 mm of the bit exposed. This limits your drilling depth and in turn minimizes your risk of causing any accidental damage to the dura.

30 Drill a small hole in the skull with care, while the assisting surgeon irrigates the area with sterile saline to prevent overheating. Minimize side-to-side movement while drilling and ensure that a hole is precise.

31 If the drill bit does not initially pierce the skull and expose the underlying dura, adjust the bit exposure by 1–2 mm. You will feel a marked change in resistance once the skull is penetrated.

32 Cut screw threads in the hole using a tap, ensuring that the screw tip does not penetrate the dura.

33 Insert a bone screw into the drilled hole and tighten it. Make sure to not over-tighten the bone screw as this could lead to damage to the dura and an eventual leak of CSF.

34 Repeat steps 30-33 until the necessary number of bone screws are in place.

35 Ensure the skull surface is completely clean and dry, with no remaining blood or tissue (only bone and screws should be visible).

36 Reattach the stereotaxic arms, one with the chamber mounted and the other with the head fixation posts, to the base unit.

37 Move the chamber holder bar as well as the head fixation posts down so that the chamber and posts are positioned close to the skull's surface.

38 Apply dental acrylic over the bone screws and around the outer wall of the chamber. The acrylic layer should be level with the tops of the bone screws. Apply dental acrylic around the head fixation post so that it connects the existing acrylic base to the post. The head fixation post should be fully encased in a thick layer of dental acrylic. Ensure there is adequate clearance between the chamber wall and the post, especially near the chamber, so that accessories like the chamber adapter and micro-drive can fit during recordings. Also be sure to cover any exposed skull surface inside the chamber with dental acrylic.

39 Confirm that all dental acrylic around the chamber and head fixation posts have fully hardened and that they are firmly secured in place.

40 Loosen the screws of the chamber holder and head fixation post holders and remove them. Detach the stereotaxic arms.

41 If any skull remains exposed, close the surrounding skin edges with sutures.

42 Place the chamber cap over the chamber and screw it in tightly.

43 Turn off the gas anesthesia and monitor the animal until it fully recovers.