Essential surgeries for the electrophysiological recording from a behaving non-human primate brain 1 (Head fixation post and recording chamber implantation)

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Protocol status: Working
We use this protocol and it's working

ABSTRACT

The implantation of a head fixation post and recording chamber is the first step to performing electrophysiological recording of head-restrained awake non-human primates. Implants can last for many years if there are no infections. However, they may fail in a few months if an infection occurs, especially between the implant and the skull. Therefore, performing surgical procedures under strictly sterile conditions is the key to the successful progress of the project.

MATERIALS

List of key materials for the head fixation post and recording chamber implantation

	Item	Specifications	Vendor	Note
	Bone screw	2.7 mm diameter 8 mm length	Movora	https://usstore.movora.com/products/2-7-cortical-screw-hex-reg-ss.html
	Hex driver	2.5 mm	McMaster-Carr	https://www.mcmaster.com/52975A16
	Drill bit	40 Gauge	McMaster-Carr	https://www.mcmaster.com/3584A225/
	Pin vise		McMaster-Carr	https://www.mcmaster.com/8455A31/

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	Item	Specifications	Vendor	Note
	Head fixation post	0.375" OD 0.192" ID 1.25" Length	McMaster-Carr (custom-made)	https://www.mcmaster.com/90138A460/ We engrave grooves on the surface, expand the inner diameter to 0.200”, and cut 1/4-20 threads.
	Chamber	0.875" OD 0.730" ID	Custom-made	
	Chamber cap		Custom-made	
	Stereotaxic frame for non-human primate		NA	
	Stereotaxic arms		NA	
	Head fixation post holder bar		Custom-made	This bar holds the head fixation post and can be secured on the stereotaxic arm
	Chamber holder bar		Custom-made	This bar holds the recording chamber and can be secured on the stereotaxic arm

Planning for the head fixation post and recording chamber im...

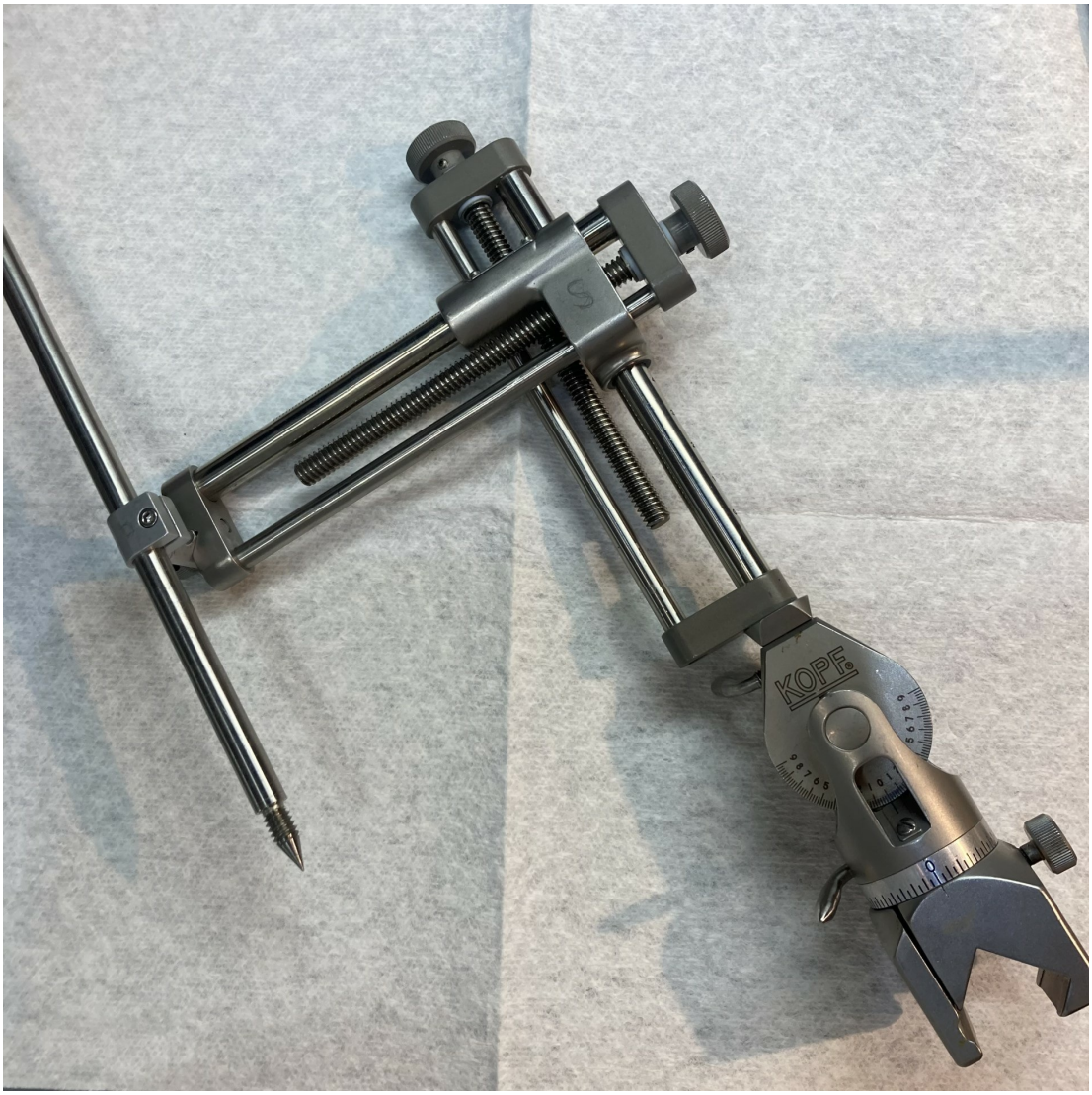
1 Calculate the coordinates of the target brain area relative to the ear bar zero.

Note

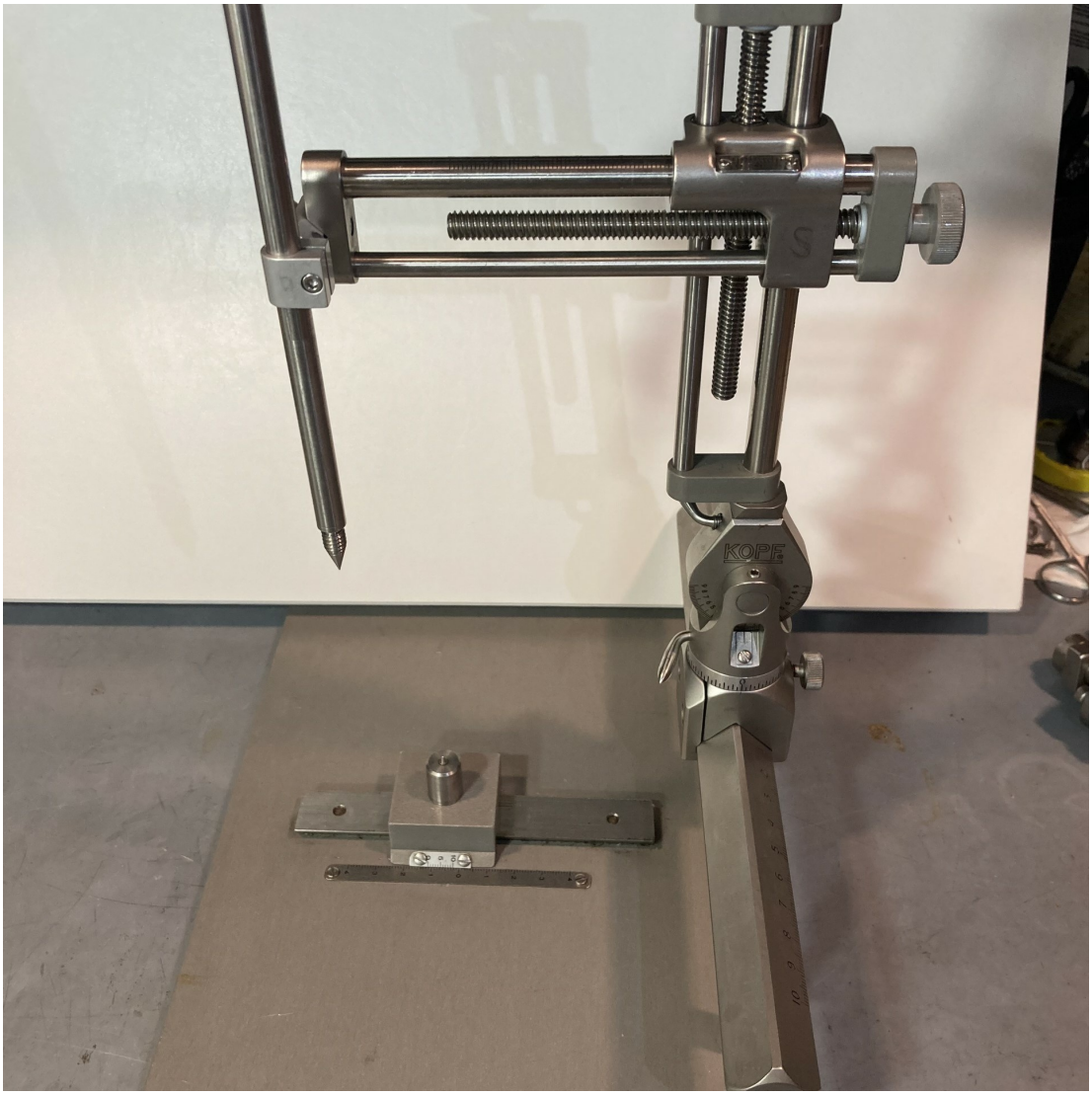
The distance from ear bar zero to the anterior commissure is different across animals.

ACX location relative to the ear-bar zero in monkey L				
	AP	ML	DV	AC-PC distance
ACX	22.5	0	16	13.2
Target coordinates relative to the ACX in the brain atlas				
	AP	ML	DV	AC-PC distance
GPi	-6.3	11.2	-3	13.1
Adjusted Target coordinates relative to the ACX in the brain atlas				
	AP	ML	DV	
GPi	-6.35	11.29	-3.02	
Target coordinates relative to the ear-bar zero in monkey L				
	AP	ML	DV	
GPi	16.15	11.29	12.98	

2 Attach the chamber holder bar to the stereotaxic arm.

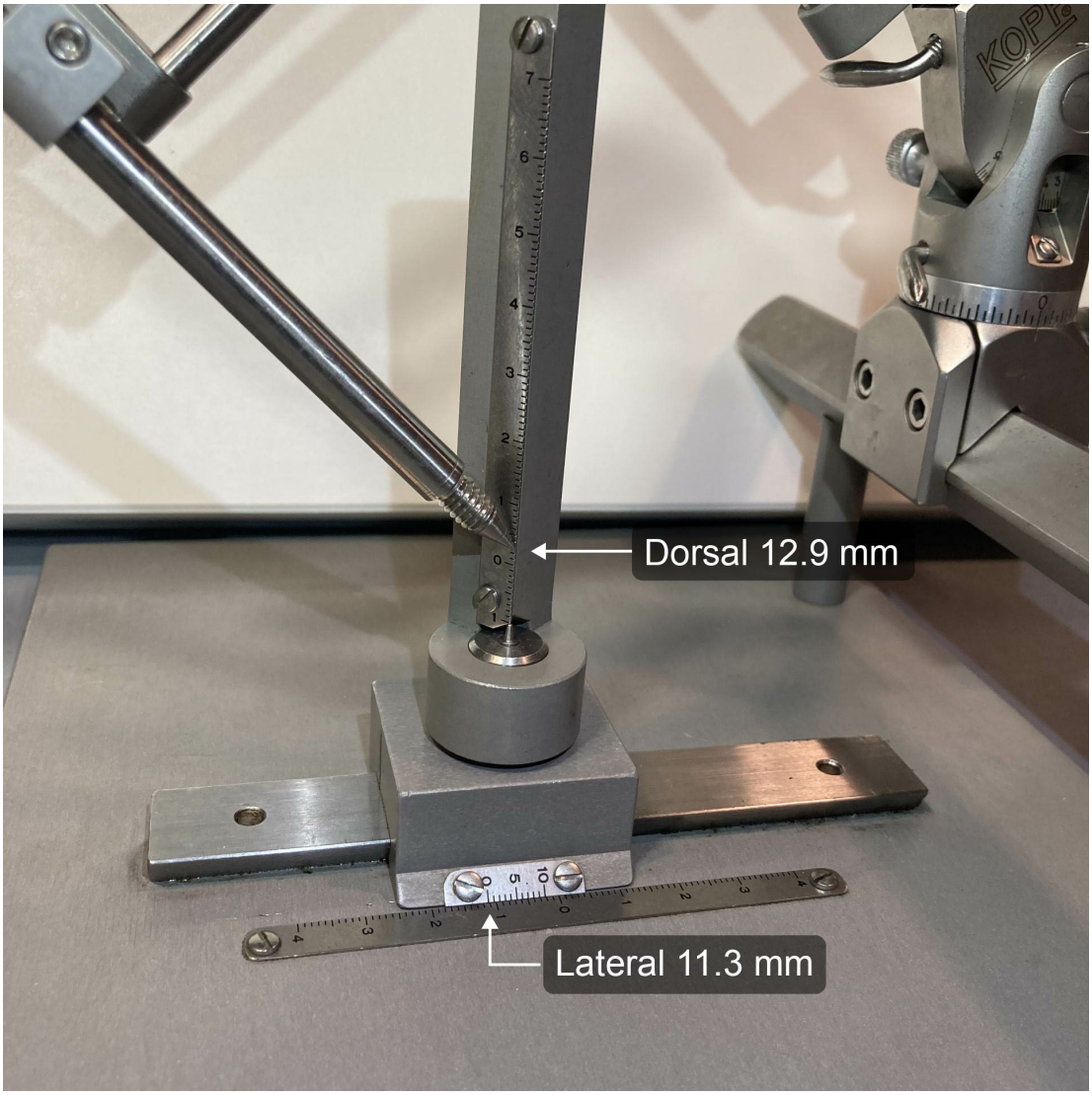


3 Mount the stereotaxic arm onto the stereotaxic calibration frame.

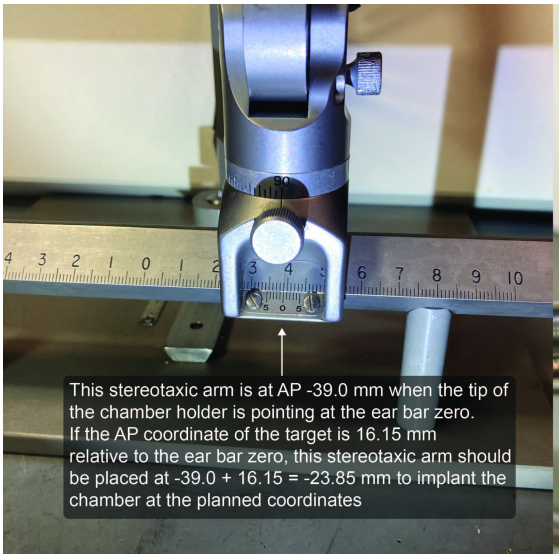


4 Adjust the angle of the stereotaxic arm if necessary.

5 Move the stereotaxic arm so that the tip of the chamber holder points at the target coordinates (except for the AP) calculated in Step 1.



6 Note the positions of the stereotaxic frame and arm (AP coordinate on the rail of the frame, ML coordinate on the stereotaxic arm, and angle of the stereotaxic arm).

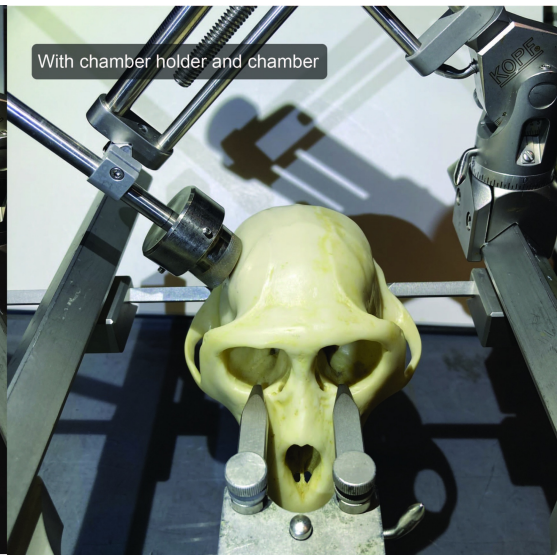


7 <Optional>

Secure a dummy skull on the stereotaxic frame, and transfer the stereotaxic arm to the stereotaxic frame to check the position of the chamber on the skull.

Note

This process is highly recommended if you plan to implant multiple chambers.



Preparation on the day before the surgery

8 Bring all sterile tools to the surgical suite and check to ensure nothing is missing.

> **Note**
>
> The authors usually align all tools on the table according to the order of use during the surgery.

9 Check if the animal is on NPO.

Preparation in the prep room on the day of surgery

10 Sedate the animal.

11 Shave the animal's hair.

12 Start the gas anesthesia.

13 Transfer the animal to the surgical suite.

Surgical procedure in the surgical suite

14 Fix the animal's head on the stereotaxic frame.

15 Wipe the surface of the animal’s head with Betadine and Ethanol.

16 Scrub both arms (5 min per arm).

17 Put on a sterile surgical gown.

18 Put on sterile gloves.

> **Note**
>
> Double the gloves so that the surgeon can continue the surgery without cleaning their hands if anything unsterile is touched during the surgery.

19 Put sterile surgical drapes onto all of the animal's body, except for the head (expose the clean surface prepared in Step 14).

20 Cut and remove the skin (usually in a round shape), and expose the skull.

21 Remove all soft tissue from the surface of the skull.

22 Cut the drape on the animal’s body around the rail of the stereotaxic frame to mount the base part of the stereotaxic arm.

Note

The scissors used for this procedure will be unsterile because the lower half of the scissors will touch the unsterile side of the drape when cutting.

23 Mount the base unit of the stereotaxic arm at the preliminary chosen coordinate.

Note

Do NOT touch the unsterile rail of the stereotaxic frame.

24 Since the rail is still exposed, we want to cover the rail of the stereotaxic frame with a new sterile drape, so that no unsterile surface is exposed. Again, please ensure to not touch the unsterile rail.

25 Mount the main unit of the stereotaxic arm onto its base unit.

26 Mount the chamber on the stereotaxic arm and move the chamber as close to the skull as possible.

27 Draw a line on the skull around the chamber.

28 Unmount the main unit of the stereotaxic arm and store it on a sterile surface.

29 Now, surgeons can check if the incision of skin is large enough. Make sure there is enough exposure of

the skull to build a dental acrylic implant.

Note

1: There should be at least 5mm from the edge of the chamber to the edge of the dental acrylic implant.
2: Do not forget to keep the space for implanting the head fixation post as well.

30 Detach the connections between the muscle and skin and between the muscle and skull.

31 Remove the muscle with electrocautery if the muscle is too close to the implants.

Note

1: Male animals usually have a lot of muscle to remove.
2: We use “HemaBlock” to stop the bleeding.

32 Put a drill bit in the pin vise, and expose the drill bit about 3-4 mm from the pin vise to prevent the surgeon from making too deep of a hole and damaging the dura and brain.

33 Make a hole in the skull by slowly turning the pin vise.

Note

1: Irrigate the skull and drill bit with sterile saline during this process.
2: Try turning the drill bit with minimum jiggling, ensuring a steady and straight drilling.

34 If the drill bit does not pierce the skull and the researchers cannot confirm the surface of the dura, expose the drill bit a little more from the pin vise and continue drilling the same hole until the drill bit pierces the skull.

Note

The torque required to turn the pin vise suddenly increases right before it pierces the skull.

35 Check the thickness of the skull from the length of the exposed drill bit.

36 Put a bone screw into the drilled hole and screw it in.

Note

Do not screw the bone screw in too much. The tip of the bone screw should be right above the dura because the pressure from the sharp screw tip will gradually erode the dura and may cause a cerebrospinal fluid leak in the future.

37 Repeat steps 32-35 until enough bone screws are implanted.

38 Remount the stereotaxic arm (and chamber) onto the base unit.

39 Make sure there is no blood or tissue on the skull, only a dry surface (and screws).

40 Move the chamber close to the surface of the skull.

41 Put the dental acrylic to cover the bone screws and the wall of the chamber.

Note

The height of the dental acrylic layer should be as high as the heads of bone screws.

42 Check to ensure all dental acrylic around the chamber is hard and that the chamber is secured in the dental acrylic.

43 Loosen the screw on the chamber holder, and unmount the stereotaxic arm.

44 Mount the head fixation post on the stereotaxic arm through the head fixation post holder, and mount the arm onto the base unit.

45 Move the head fixation post close to the dental acrylic.

46 Put dental acrylic around the head fixation post to bridge the existing dental acrylic and the head fixation post.

Note

1: The head fixation post should be covered with a thick layer of dental acrylic. Make sure there is enough space between the chamber wall and the head fixation post (especially around the chamber, since the chamber adapter and micro-drive for the recording will occupy some space during the recording).
2: Do not forget to cover the surface of the skull inside the chamber.

47 Optional procedure – if the researchers will use a chamber adapter for the recording, this is the best timing to align the mediolateral and anteroposterior axes with the stereotaxic coordinates.

48 Unmount the stereotaxic arm.

49 If the skull is exposed, researchers need to tighten the edge of the skin.

50 Make a V-shape incision on the edge of the skin, and suture the sides of V.

51 Put the chamber cap onto the chamber.

52 Stop the gas anesthesia and wait for the animal’s recovery.