

# NCAN Summer Course: Training Exercise 1

## ECoG/Nerve Cuff Surgery Procedure

### PRE-SURGERY PREPARATIONS

#### Getting your station prepared

- Arrange tools found in kit: scalpel and blade; fine forceps (Dumont-style #5 straight and 45° angled); iris scissors; toothed forceps; wound clip applicator; round bur; drill; retractors
- Arrange supplies: cotton-tipped swabs, gauze pads, wound clips
- Position rat prone



#### Secure head in ear bars

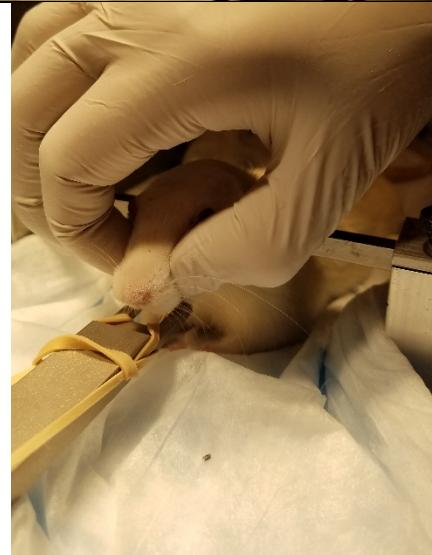
- Lock one ear bar in place with the point in line with the corner of the nose piece
- Tilt head and insert the ear bar into the side locked in place, it will feel as if the bar has been inserted into a hard cup
- While still holding the head, bring the other ear bar into the ear
- Once that one is also in place, tighten that ear bar
- The head will be able to move up and down, but not side to side





#### Mouth Bar

- Once the ear bars are in place, open the mouth and hook the front teeth over the mouth bar
- Put a rubber band over the nose to hold the head down
- Pull the mouth bar so that the head is completely locked in place
- Make sure head is level by changing the height of the mouth piece



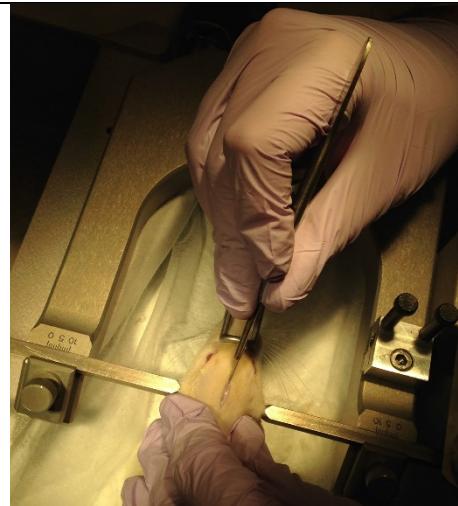
#### Starting the Surgery

- Shave fur over skull and hindlimb
- Set up retractor holders
- Tape foot into position
- Scrub skin over skull and back of hindlimb three times, alternating between iodine-based solution (e.g., Betadine) and 70% ethanol
- Install and secure #65 bit in drill
- Fill syringe with saline
- Mark incision sites



#### NERVE STIMULATION CUFF AND EMG ELECTRODE PLACEMENT (performed by surgeon A at same time that surgeon B performs ECoG electrode array placement)

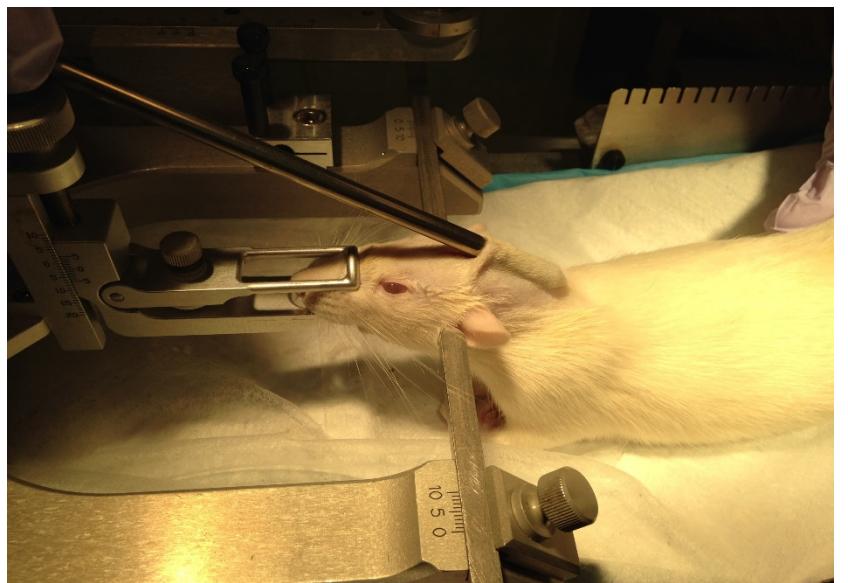
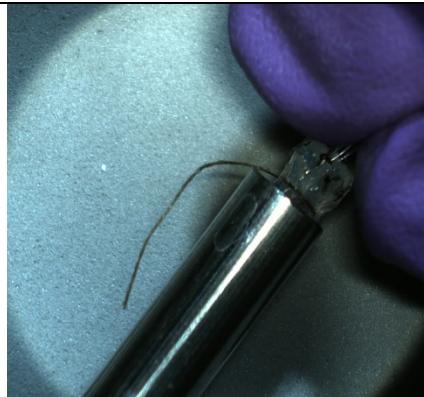
- Use scalpel to make a midline incision in skin over the skull from just caudal to the eyes to caudal edge of the earbar.

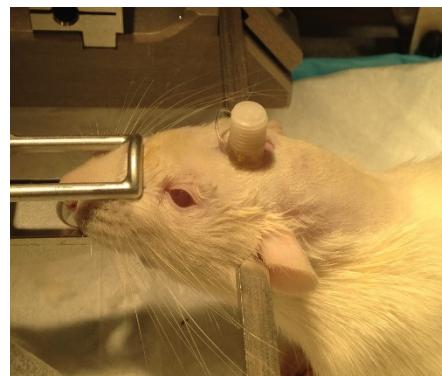
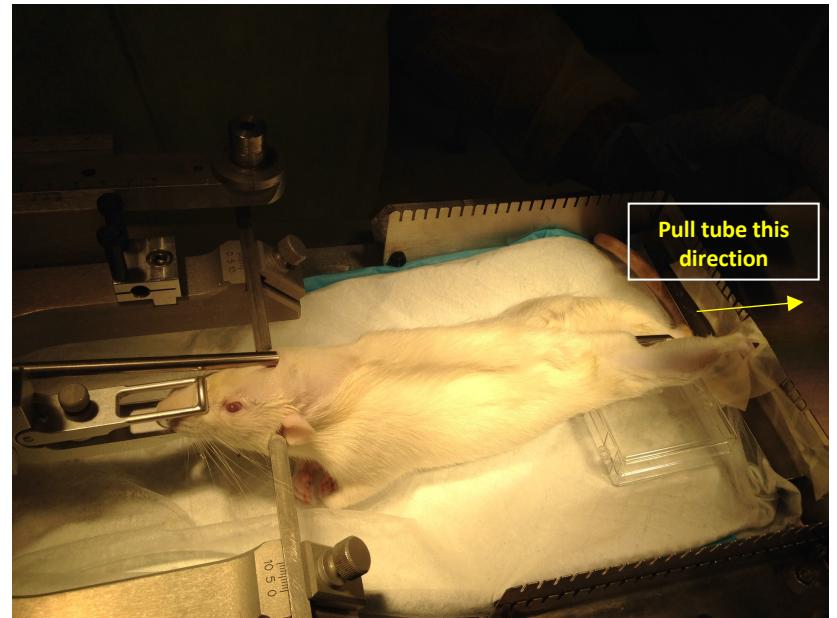


- 2) Use scalpel to incise the skin over the back of the thigh and knee of the left hind leg.

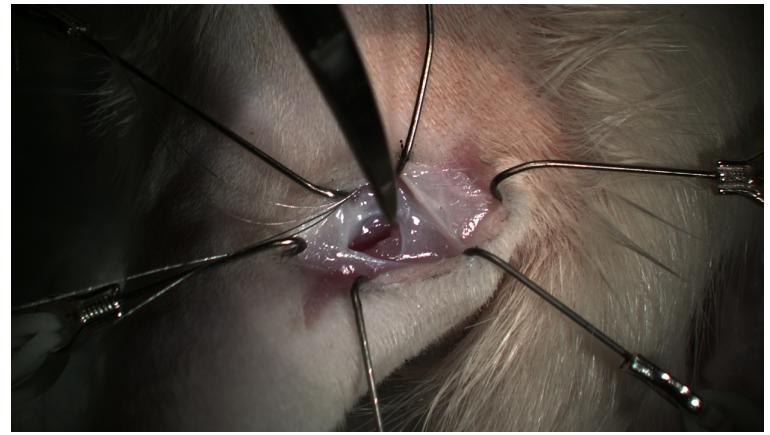


3) Insert EMG wires into steel tube.  
Then, place nerve cuff in steel tube.  
Try to get the cuff all the way in by  
feeding it through, then push into tube  
using smaller metal tube as a ramrod.  
The white socket will dangle from end  
of tube. Cap other end with metal  
point. Insert pointed end of tube into  
head incision, and feed through just  
under the skin until pointed end  
emerges from leg incision. Remove  
the metal tube leaving the cuff  
dangling from the leg incision and the  
white socket dangling from the head  
incision.



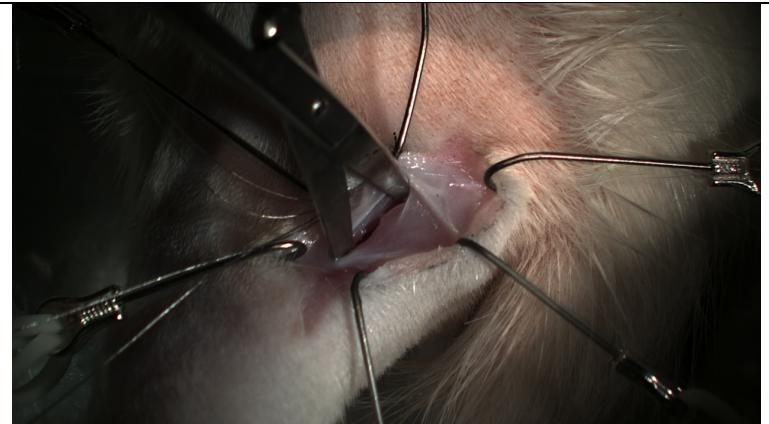


- 4) Use retractors (ball chains with hooks) to pull back skin and apply light tension by attaching ball chain to slots in frame.



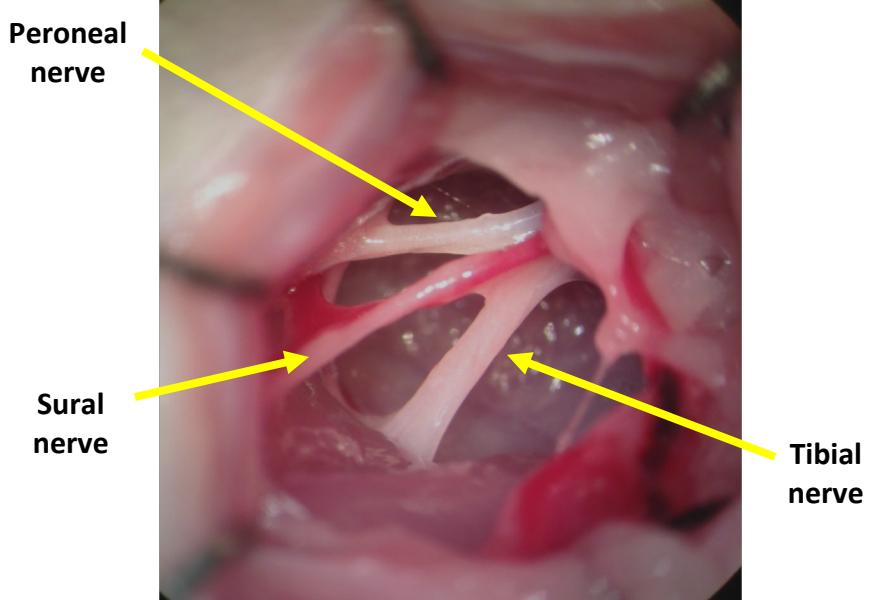
5) Identify fatty tissue at the back of the knee to use as starting point for dissection; separate muscle and fatty tissue with scissors to expose posterior tibial nerve.

- Do not cut with scissors; insert closed and then open in parallel with muscle fibers for blunt dissection of tissue

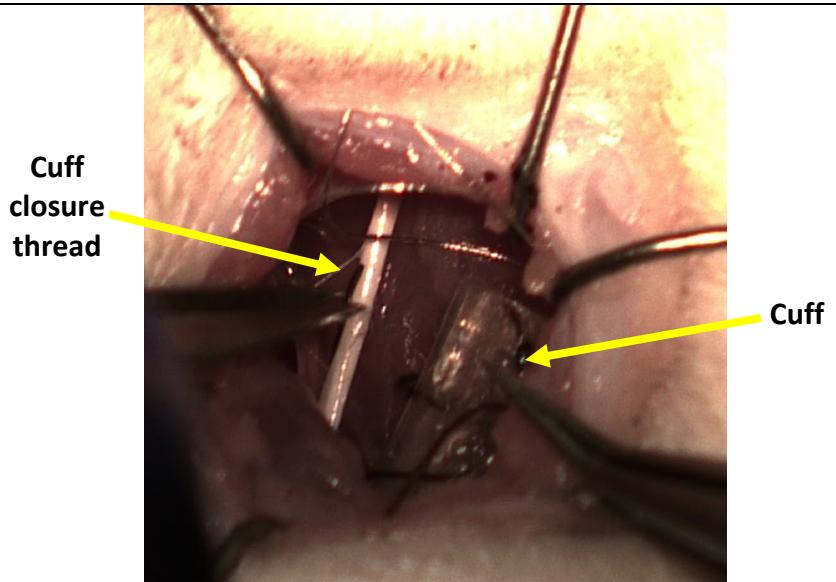


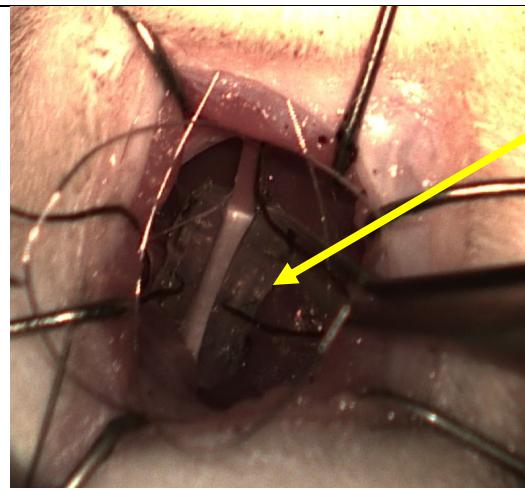
6) Reposition hooks as needed to get a better view of work area; keep tissue moist with saline.

- Identify posterior tibial nerve and separate from adjoining nerves (peroneal, sural) and muscle by blunt dissection with scissors and/or fine forceps in parallel with the nerve; expose enough nerve to apply stimulation cuff ( $\geq 8$  mm)

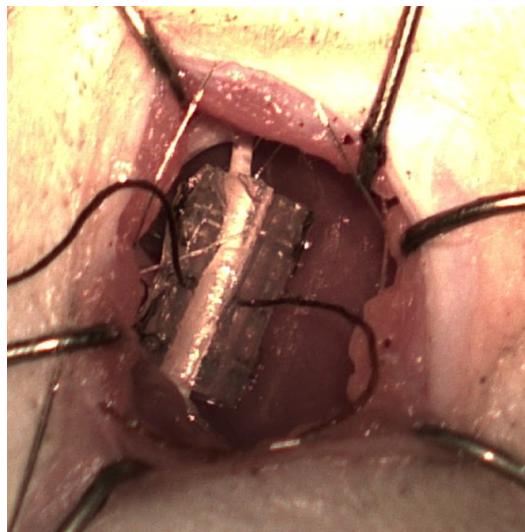


7) Position stimulation cuff next to nerve with wires pointing rostrally; use angled fine forceps to reach under nerve and grab one of the cuff closure threads and pull under nerve.

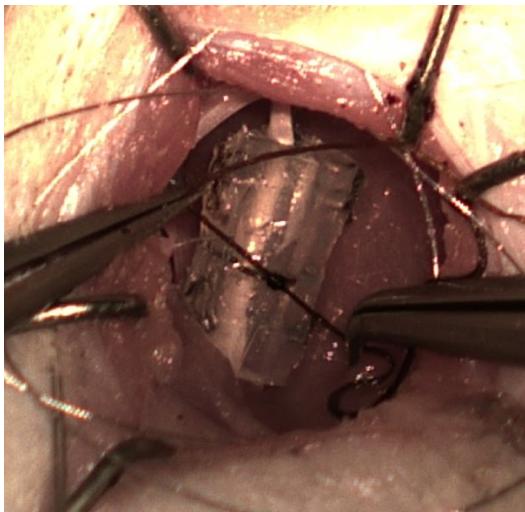




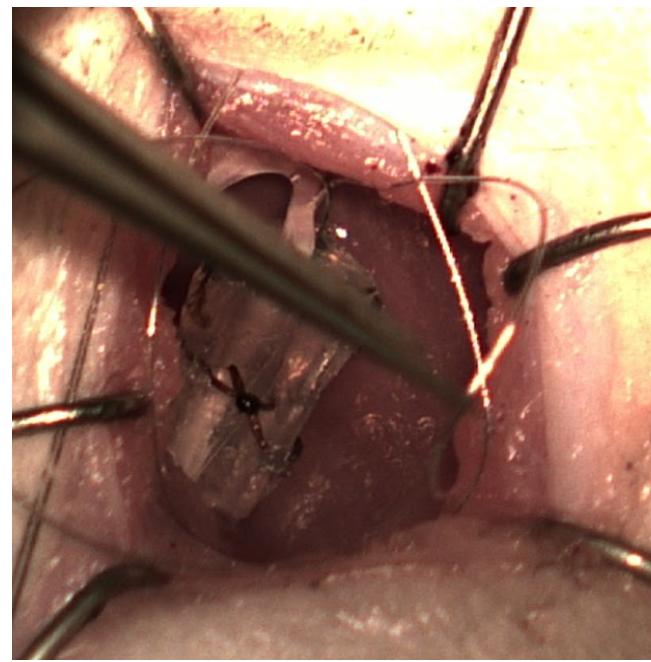
- 8) Grab both cuff closure threads open cuff and pull under nerve; release threads to allow cuff to close.



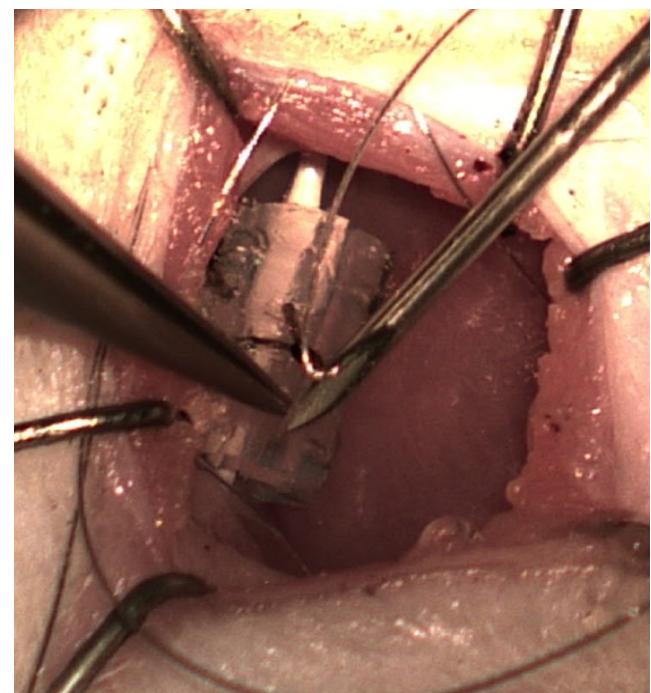
- 9) Once the cuff is around the nerve, tie cuff closure threads together and trim ends of threads.



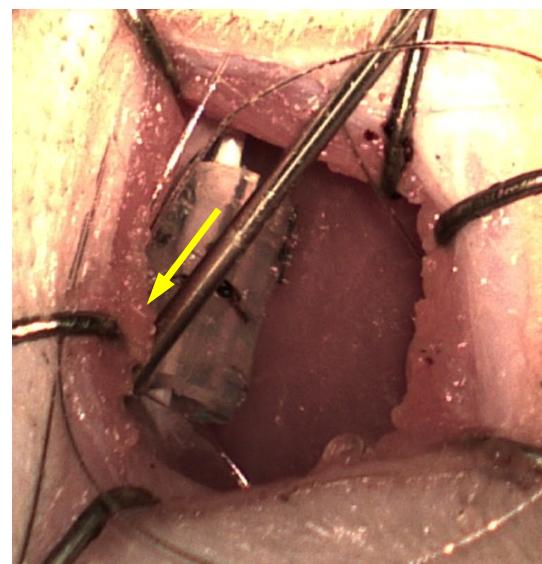
10) Form excess wire into a loop and insert into dissection cavity under muscle. Secure wires to muscle with a single suture tie near to the point where the wires exit the leg incision to travel subcutaneously towards the head.



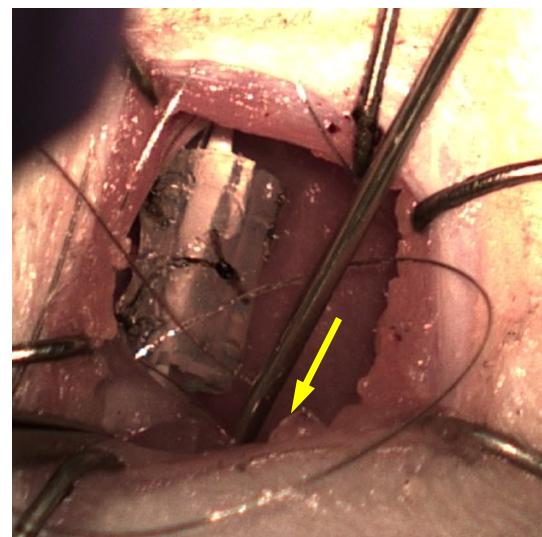
11) Use syringe needle (27 ga) to insert EMG wire into muscle. Insert wire into needle tip up to the insulated area; bend back the insulated part to create “fish hook” shaped tip.



12) Insert needle into lateral head of gastrocnemius muscle (in direction of yellow arrow). Remove needle while holding onto the wire with fine forceps.



13) Repeat steps 26-27 for second wire, inserting it into the medial head of the gastrocnemius muscle (in direction of yellow arrow). Bury extra EMG wire in dissection cavity if necessary. Secure wires to muscle with a single suture tie near to the point where the wires exit the leg incision to travel subcutaneously towards the head.



14) Reposition retractors from muscle to just hold skin, allowing incised muscle edges to reappose.

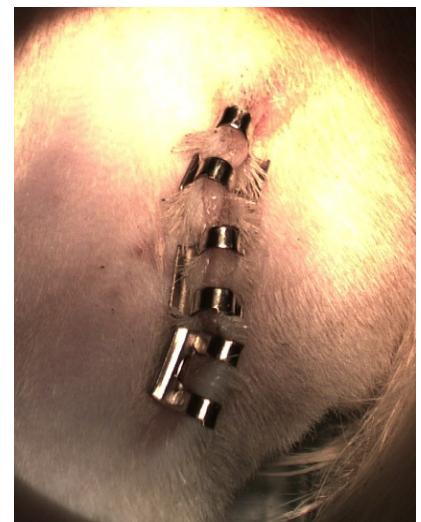


15) Close the muscle incision: place first suture in the mid-incision; needle should pass through aponeurosis (white tendinous sheet on outer muscle surface) and muscle, and then tie a square knot; repeat suturing as needed (typically 3-4 in all).

- Do not get wires trapped in knot
- Can do continuous suture instead of interrupted sutures—should be faster



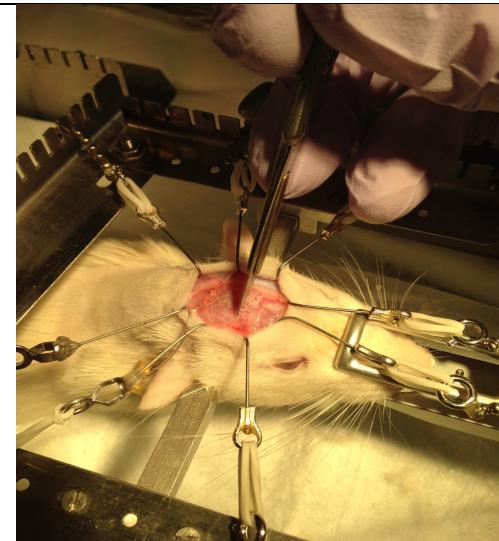
16) Appose skin edges and apply wound clips along the incision.



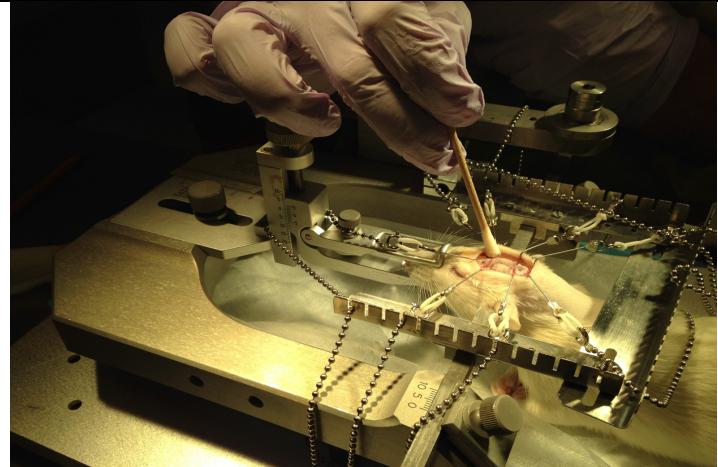
**ECOG GRID PLACEMENT (performed by surgeon B at same time as surgeon A does nerve stimulation cuff and EMG wire implantation)**

17) Apply retractors to skin to expose skull; use scalpel to scrape away periosteum.

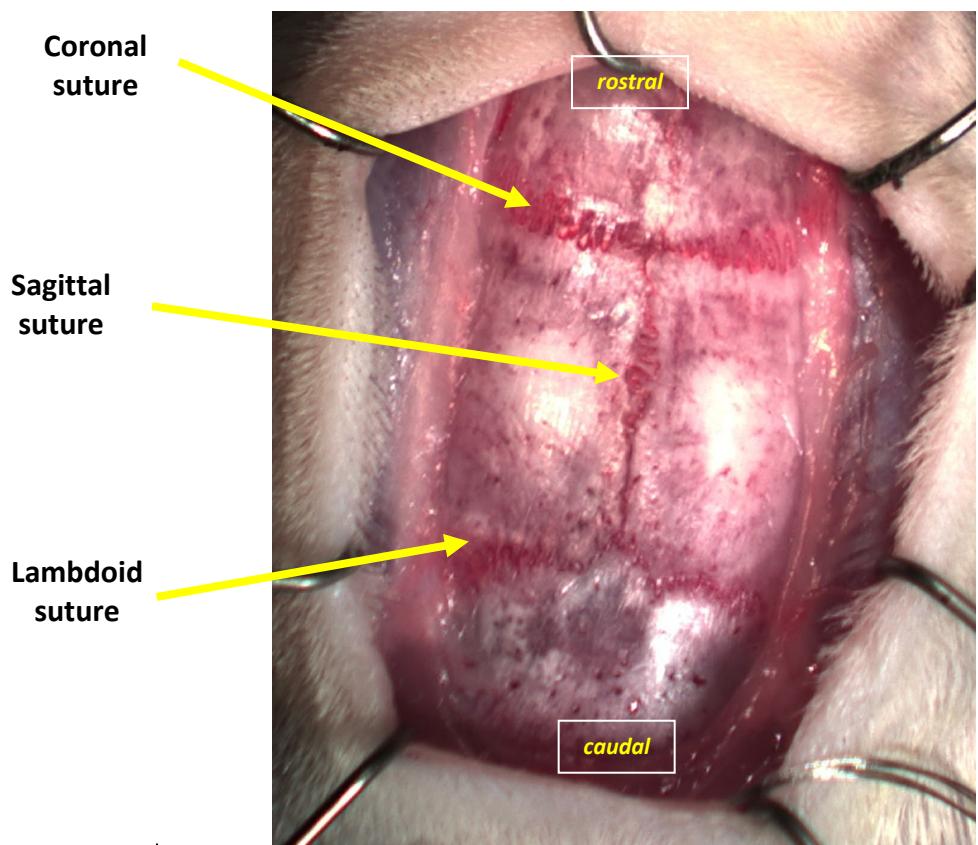
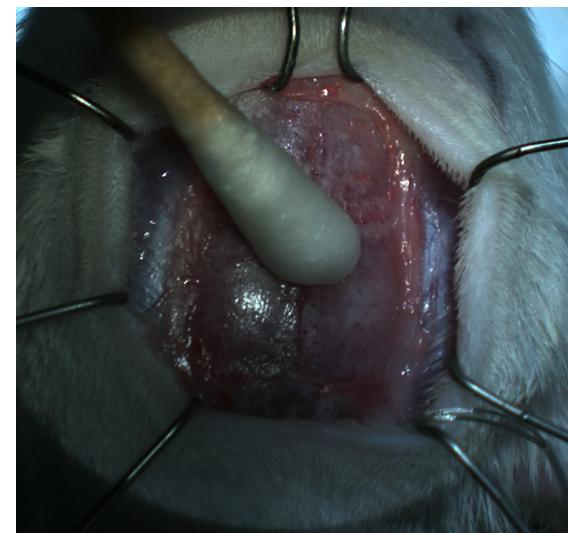
- Scrape medially to laterally to bony ridge
- Can also rub with gauze pad to remove periosteum



18) Adjust retractors to expose skull and dry area with cotton swabs.

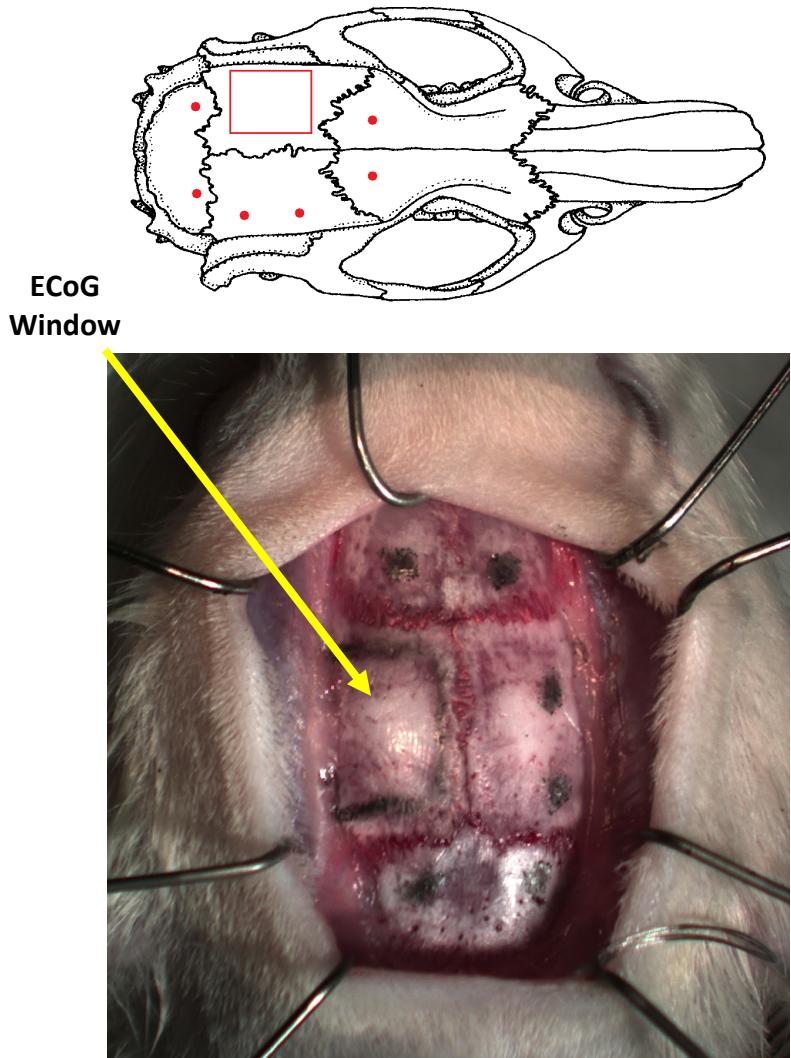


19) If needed, apply swab moistened with hydrogen peroxide to exposed skull for better visibility of bone sutures.

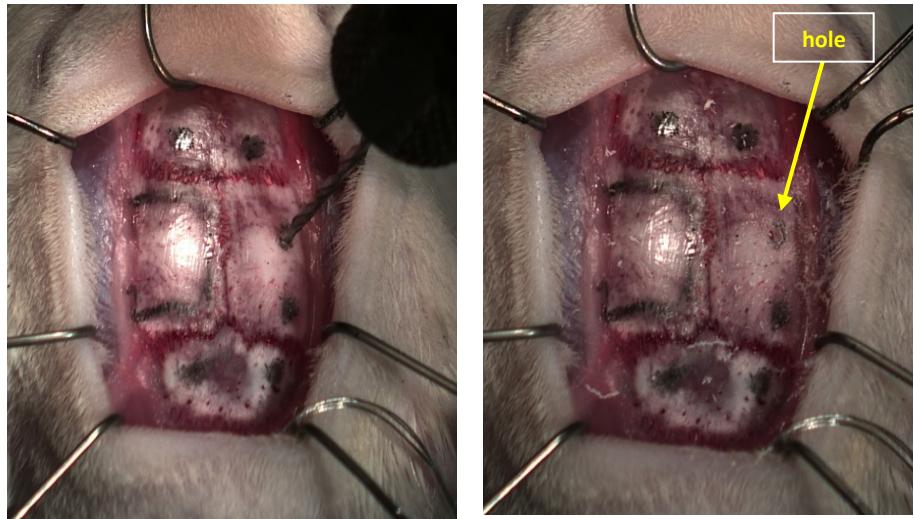


20) Use pencil to mark screw locations and ECoG window.

- Draw rectangle on skull within parietal bone staying 1 mm away from sagittal (midline), rostral (coronal) and caudal (lambdoid) sutures. The rectangle should be at least 6.5 mm in the rostro-caudal dimension.

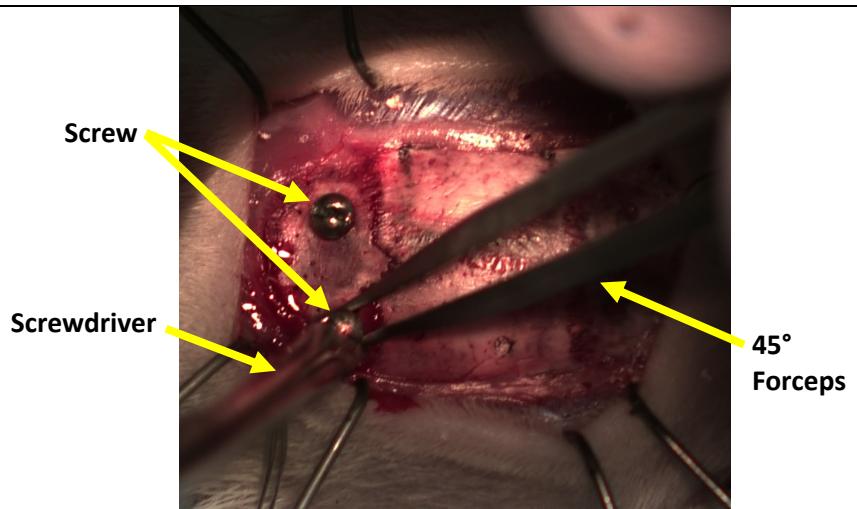


21) Hold rotary tool tangent to skull at marked locations and drill holes at low speed. Support drill with both hands and apply only gentle pressure. Drill will advance suddenly when skull is punctured, so be prepared to resist this.



22) Use 45° fine forceps to hold screw over hole while turning screwdriver. Continue until screw “bites” and then make ~2 (front 4 screws) or ~3 (back 2 screws) more full rotations

- Do not make flush with skull; screw head should be at least 1 mm above skull

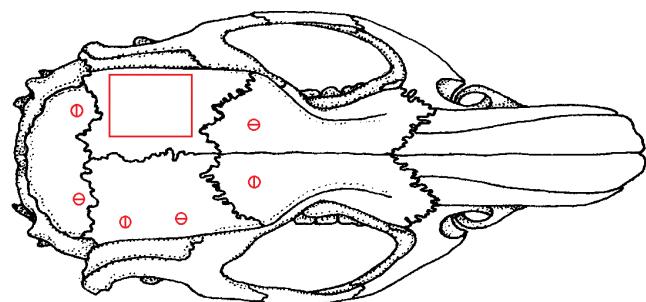


23) Repeat step 37 until all screws are in place (surgeons should trade positions so each one can drill holes and install screws).



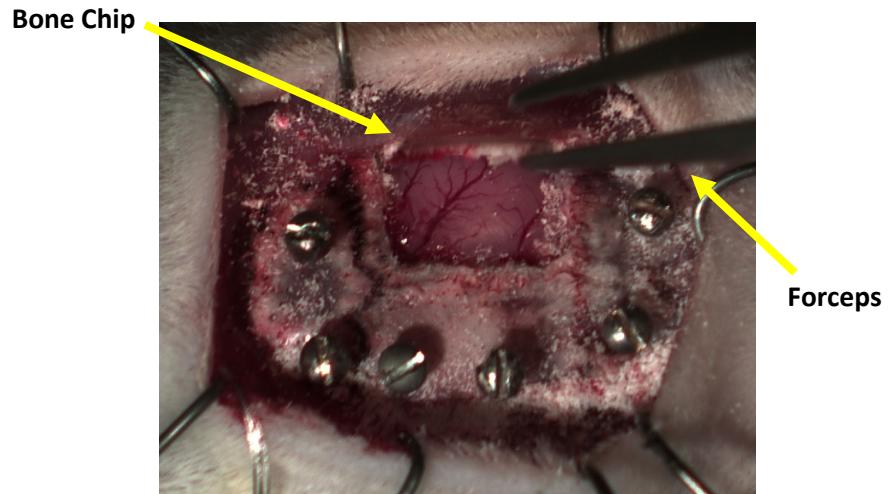
24) Remove bit from drill, replace with round bur, and grind a narrow trench along the pencil line.

- Keep drill away from skin
- Try to cut groove evenly; don't make a series of holes if you can help it

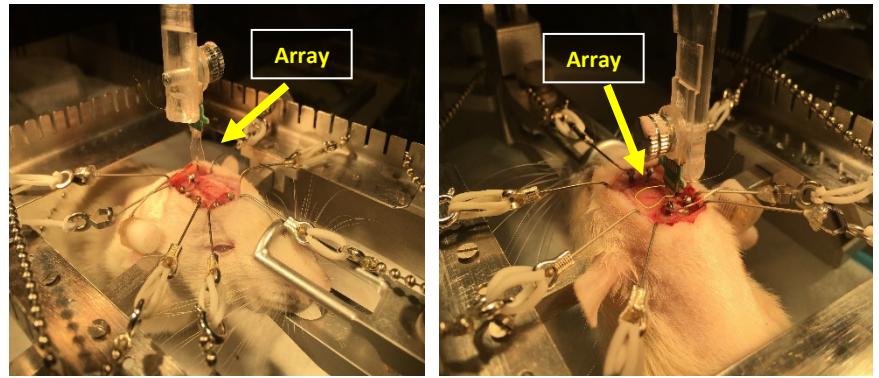




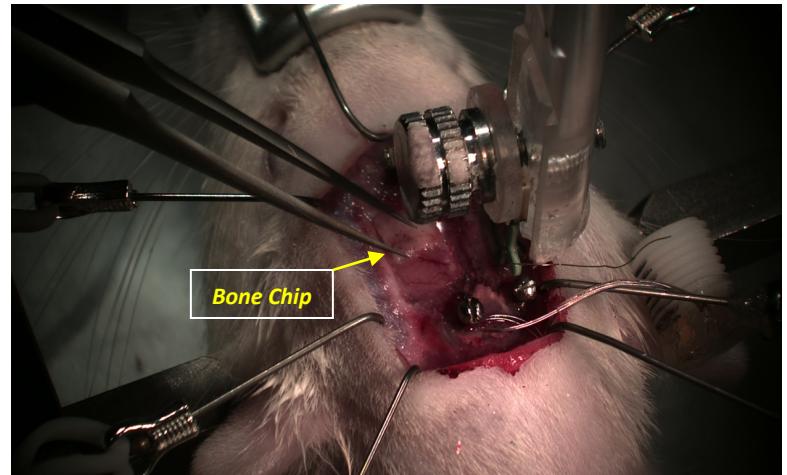
25) Remove skull fragment with tweezers and place to the side (will be used later); keep exposed dura moist with saline.



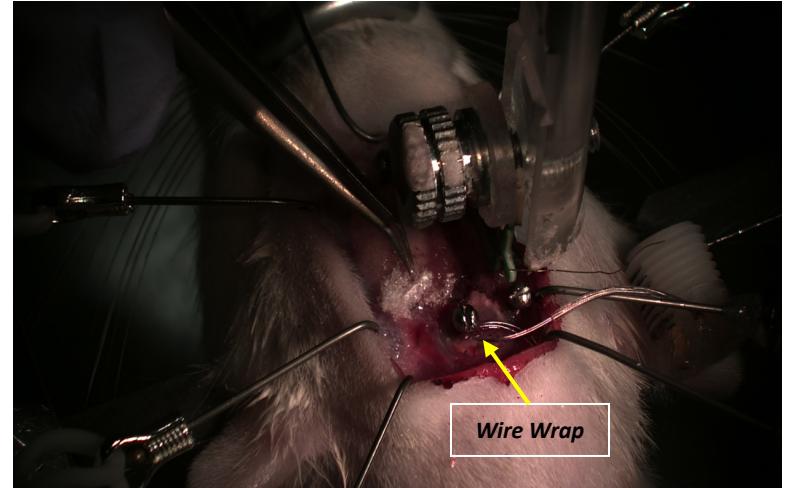
26) Mount manipulator onto frame and attach ECoG electrode array. Lower the array onto exposed dura starting with far end of array at lateral edge of bone opening; adjust manipulator to lower grid onto dura. Final position of the array connector should be 1-2 mm lateral to midline on side opposite to array.



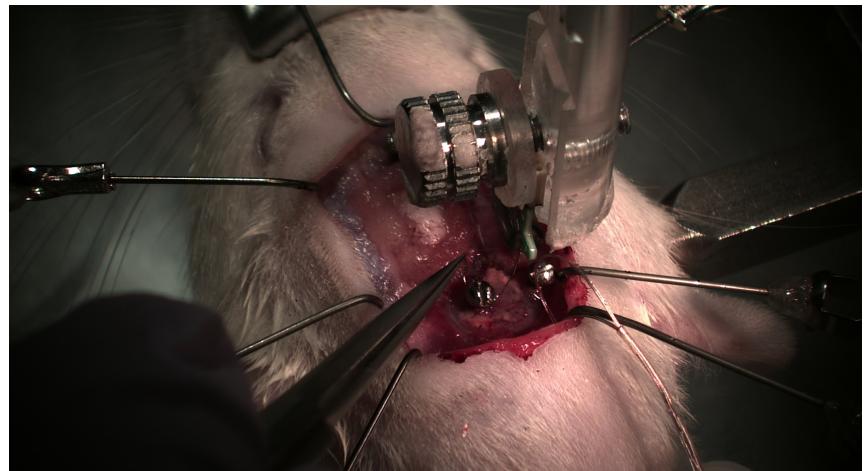
27) Position skull fragment back over the bone window on top of the ECoG array.



28) Apply moistened Gelfoam to fill the spaces between the skull and the fragment.

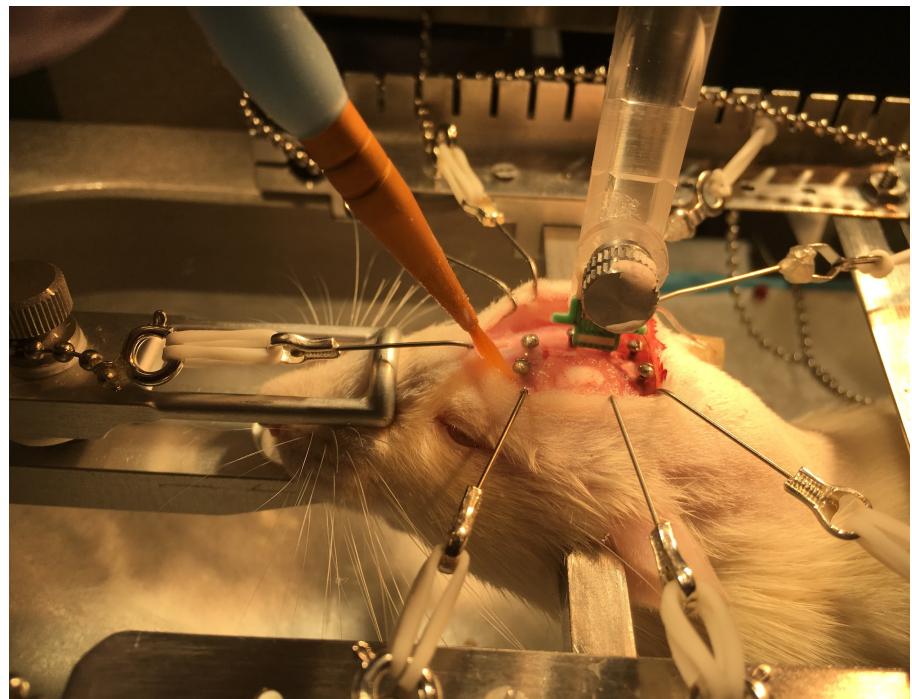


29) Wrap at least 1.5 cm of ground wire around one of the skull screws, leaving a few mm of slack in wire.

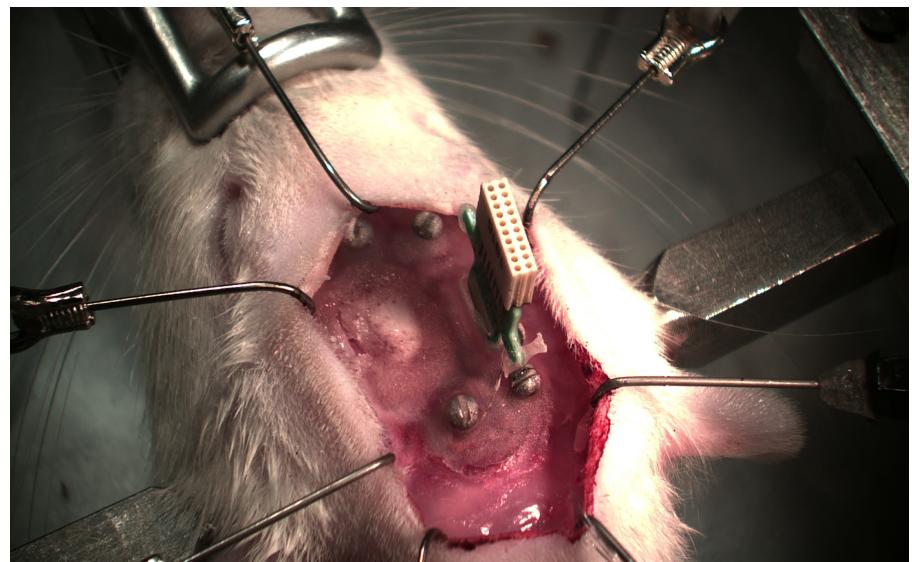


30) Use paint brush to mix and apply 2-3 batches of solvent/cement mixture over the bone fragment, Gelfoam, and screws (make sure you get cement under the screw heads).

- Solvent cement should be mixed and applied rapidly



31) Carefully remove ECoG mounting rig after initial cement is placed; apply gentle pressure to ECoG connector to tilt top laterally ~10°.



32) Position white socket over cement that covers the replaced bone fragment as medial as possible. Route wires to lie flat; push excess wire back under skin. Tilted slightly laterally to allow access for connecting plug.

- Continue to apply cement until the screws, the bottom 3-4 threads of the white socket, and the green circuit board of the ECoG array are covered. Final product will be a mound highest at midline that slopes down to an oval with a smooth “shoreline” on the skull.
- Avoid forming “cliffs” or having indented “bays” around the base of the skull
- Using forceps remove any cement from the skin. Use scalpel to cut away excess cement around base of mount



33) When mount is complete, remove retractors and allow skin to conform to edges of mount. Apply sutures to skin if needed to snug incised skin around mount.

