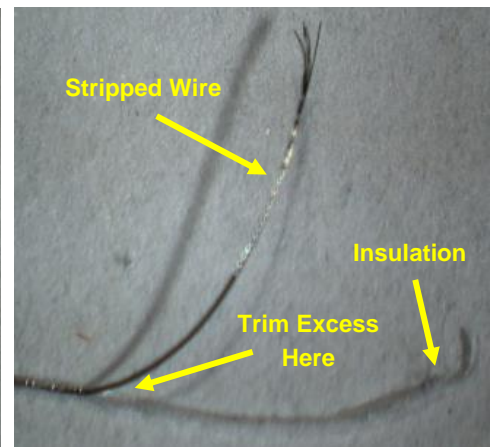
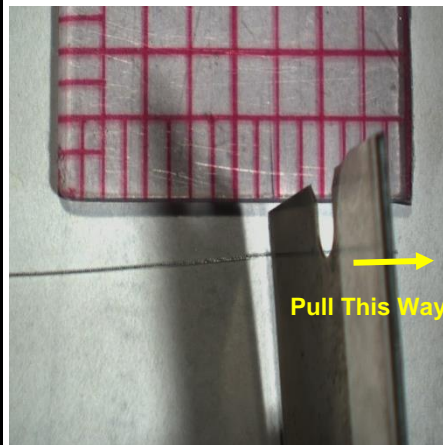


NCAN Summer Course: Training Exercise 1

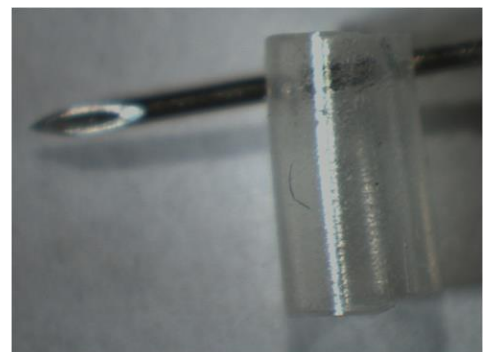
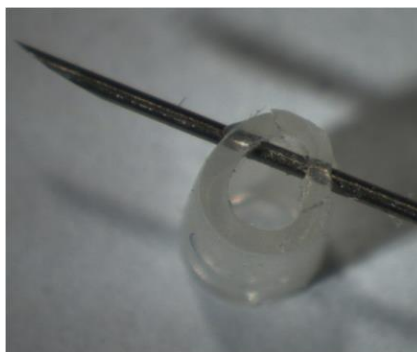
Procedure for Making Peripheral Nerve Stimulation Cuffs

NERVE CUFF

1. Hold one nerve cuff wire firmly against a hard surface with fingers. Position razor blade perpendicularly. Apply gentle pressure with razor blade to nick insulation (not wires) about 8 mm from one end of wire; slide blade towards end of wire to strip off the insulation. Use forceps or razor to remove any insulation still attached.
 - If wire frays, grab ends of wires with forceps and spin insulated wire with fingers to twist ends together or just cut off frayed end; repeat as needed.
 - Peel insulation off gently or wire will curl, which makes it more difficult to work with.

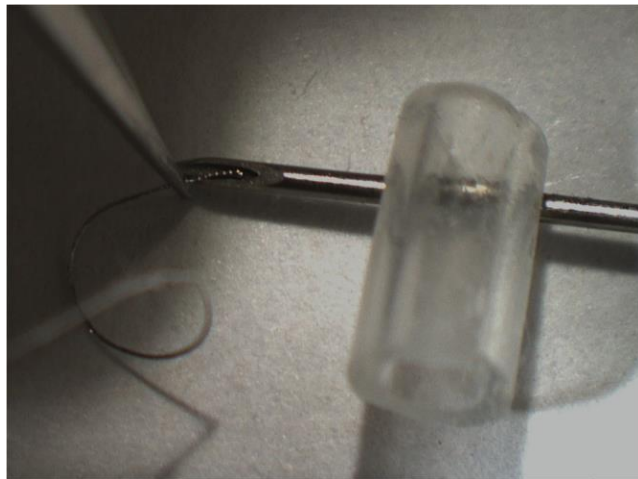


2. Cut off a 4-mm length of the larger silicone rubber tubing. Insert needle 1-mm away from one end so that it pierces both side of the tube.
 - If you imagine a clock face, the needle should enter at 1:30 and exit at 10:30 (or the reverse).
 - Needle should be in the top 1/3rd of tube when looking through it.



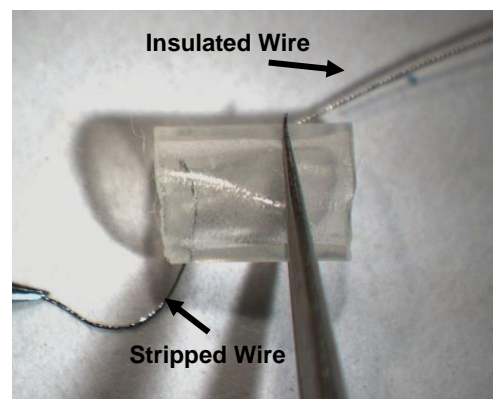
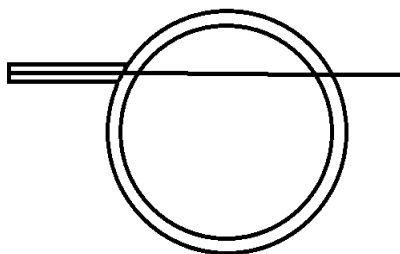
3. Insert the stripped end of one of the wires into the tip of the needle protruding from the side of the tube.

- Make sure that the stripped wire does not unravel; if this does occur, twist back together or cut off frayed end and repeat steps 1 and 2.



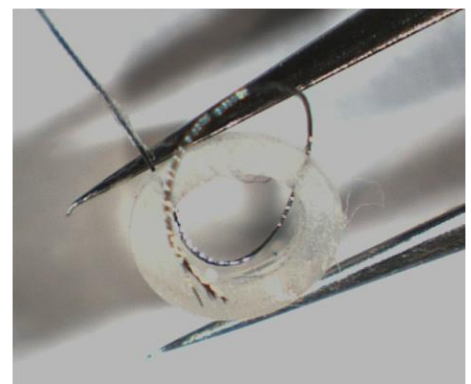
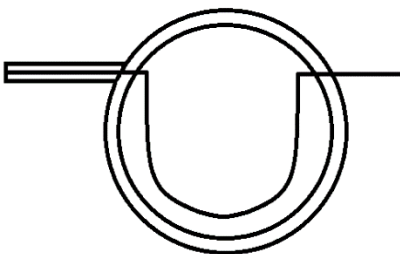
4. After the wire is inserted into the needle opening, remove the needle from the tubing leaving the wire running across the width of the tube. Pull the stripped end until the insulated side is right against the tube.

- It's ok if the wire curls but it will be easier to work with if it remains straight



5. Using fine forceps, curve the wire into a Ω shape that follows the inner diameter of the tubing.

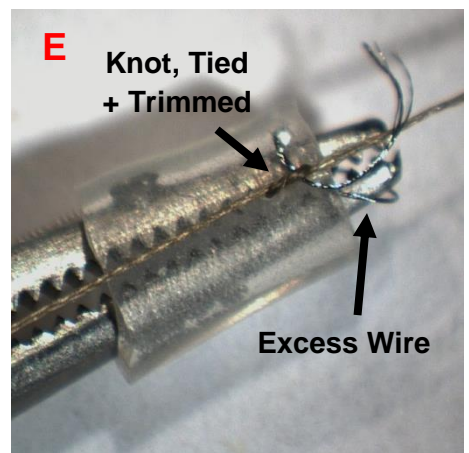
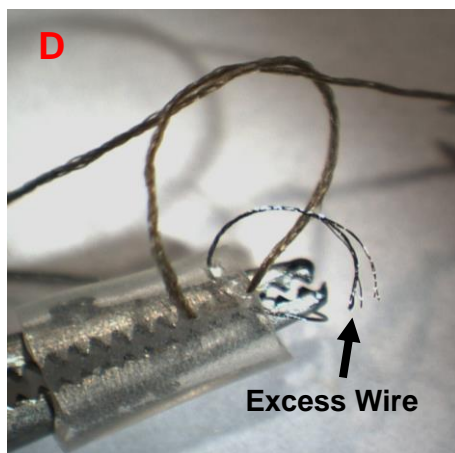
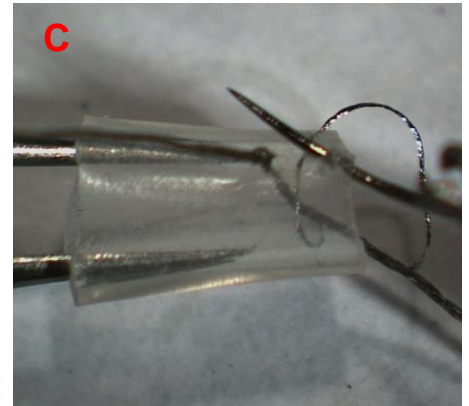
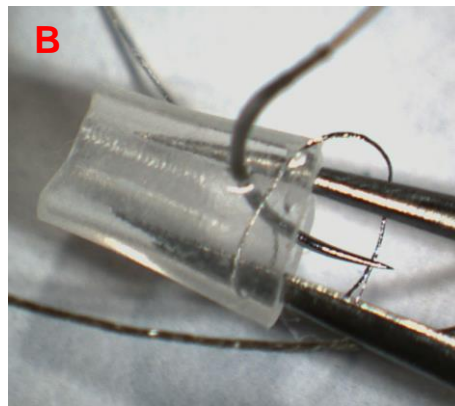
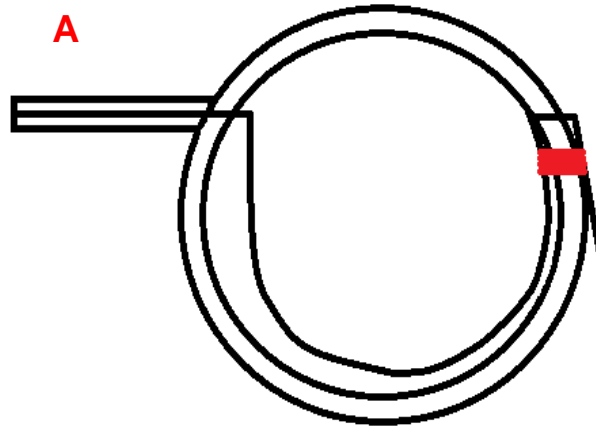
- It's ok if the wire refuses to maintain the desired shape. It will be secured into place by sutures in the next step.



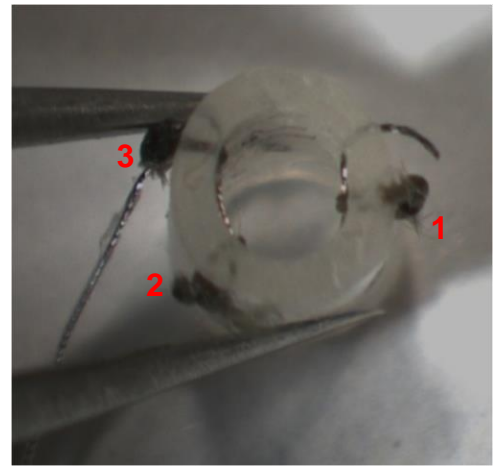
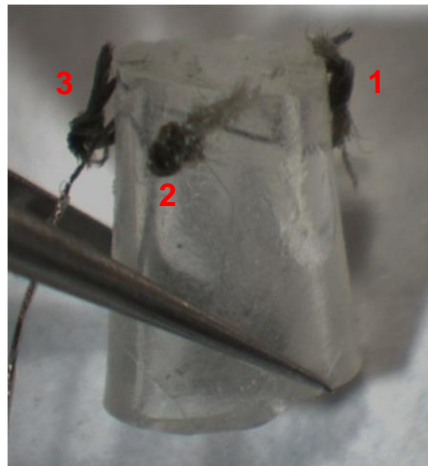
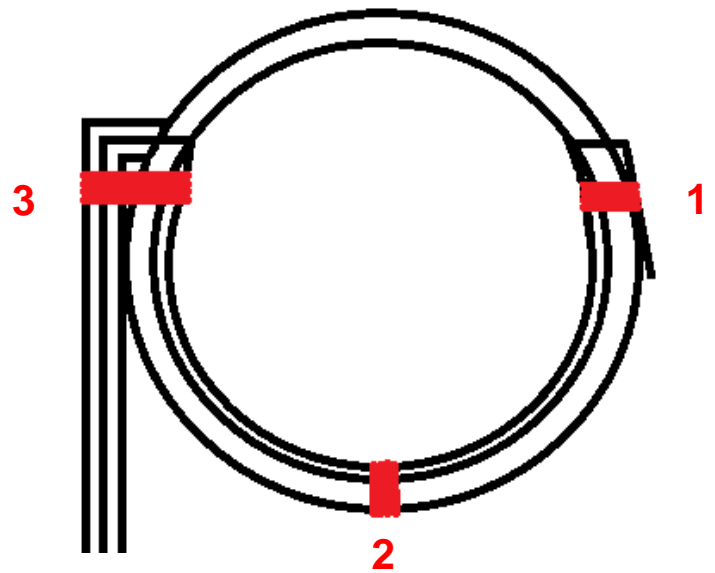
6. **A:** Cartoon of wire loop in tube for securing the side with the short wire. **B:** Using the wire along the inside of the tube as a guide, pierce the tube ~0.5 mm away from the wire on one side and drive the needle through going from outside → inside. **C:** Repeat this for the other side of the wire, but with the needle moving from inside → outside the tube. **D:** Bend down the extra wire so that it is touching the tube and secure with square knot. **E:** Trim excess thread.

- Make sure the knot encompasses the inside wire, tube, and bent outside wire
- Refer to Knot Tying Tutorial handout for instruction on tying knots using instruments, or see video at:

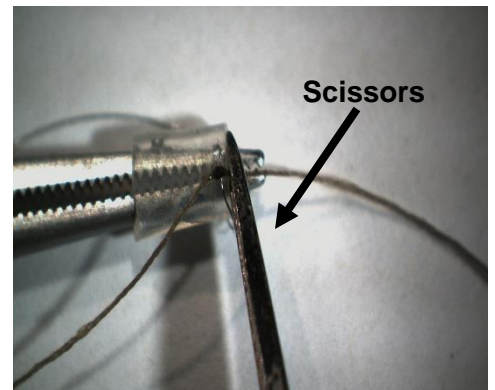
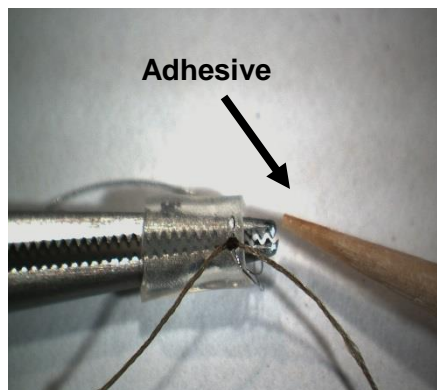
■ <https://www.youtube.com/watch?v=wbpQhiNDxvo>



7. Repeat step 6 for both the middle of the arc and other end of the tube (3 separate knots in all).

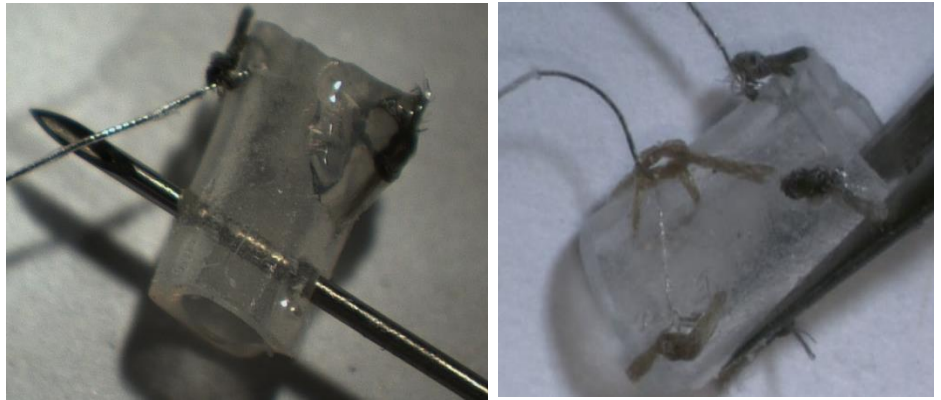


8. Secure each knot by putting a very small amount instant adhesive onto the tip of a toothpick and then dabbing the glue onto each knot. Use just enough glue so that it seeps into the thread and turns it a shiny, darker black. Trim excess thread.

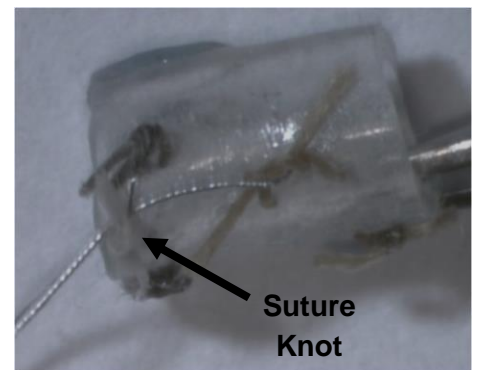
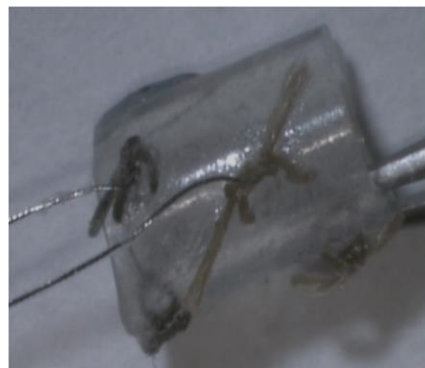
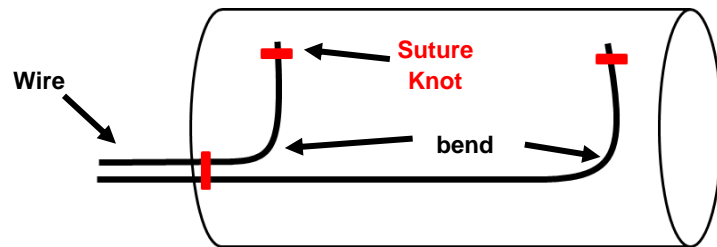


9. Repeat steps 1-8 for the other end of the cuff to position the second electrode.

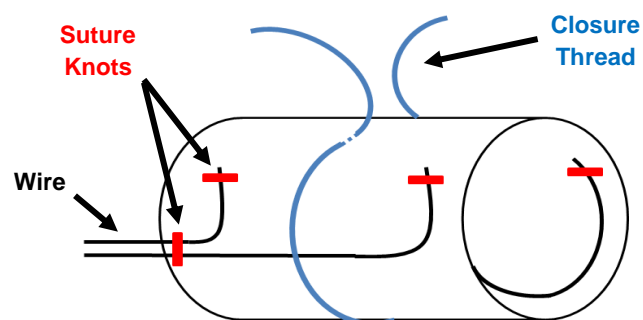
- The Ω -shaped wires should be parallel to each other and perpendicular to tube.
- There should be a narrow strip without any wires/knots along the top of the cuff.
- Make sure that both the long wires enter the tube on the same side.



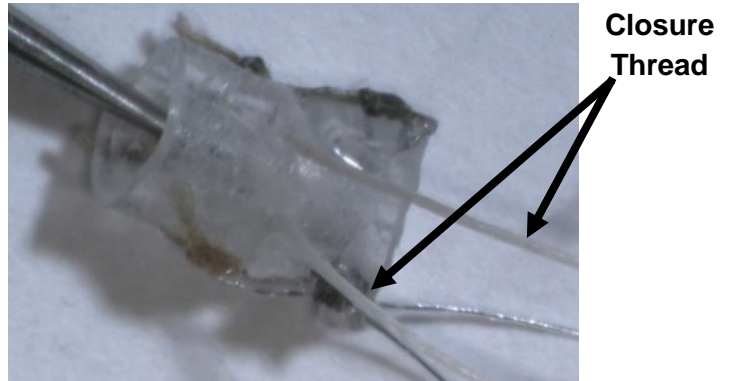
10. Bend the two long wires at 90° just beyond the place where they are tied to the cuff so they are aligned with the long axis of the tubing. Secure them together with suture to the far end of the tubing.



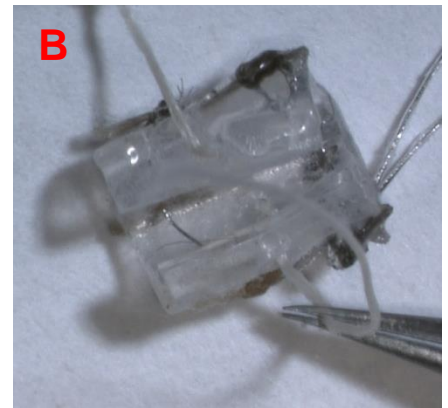
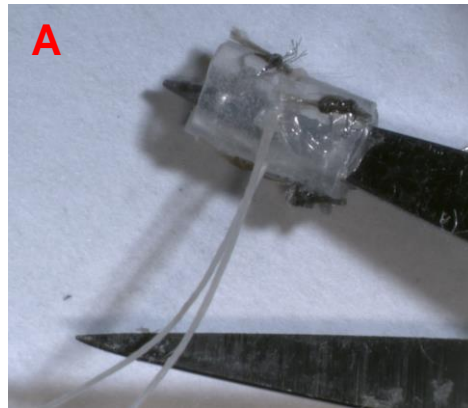
11. Making the nerve cuff closure tie: In the middle of the cuff (in between the two loops), insert the suture needle at 1 o'clock and emerge again at 3 o'clock; wrap the thread around the outer surface of the cuff, and insert the needle through the



tubing at 9 o'clock and emerge at 11 o'clock. This should make an upside-down Ω shape, with a majority of the thread wrapping around the outside of the cuff and as little thread present on the inside of the cuff as possible.



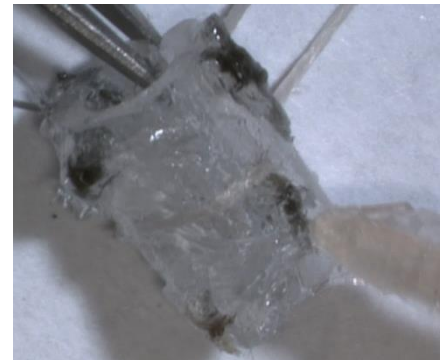
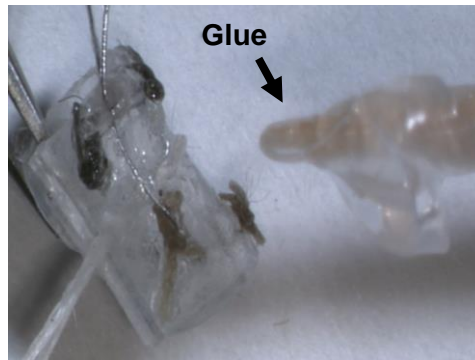
12. In the empty space between the entry and exit point of the previously inserted thread, cut the cuff lengthwise, being careful to avoid cutting through any wires (**A**) to allow the cuff to be opened by retracting the closure threads (**B**).



13. Using scissors, trim any long ends of suture thread (except for the cuff-closure thread from step 12) as well as the short end of wire so that it protrudes as little from the cuff as possible.



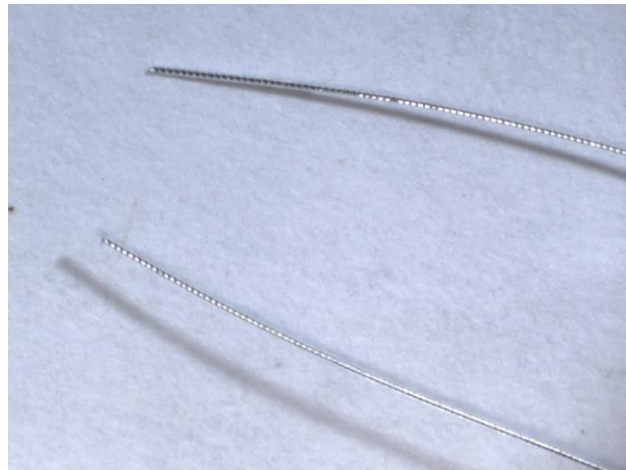
14. With the biocompatible glue and toothpick, coat the outside surface of the cuff so that the short end of each wire is covered, as well as all knots. Avoid covering the surface of the cuff where the lengthwise cut was made.



CONNECTING SOCKET

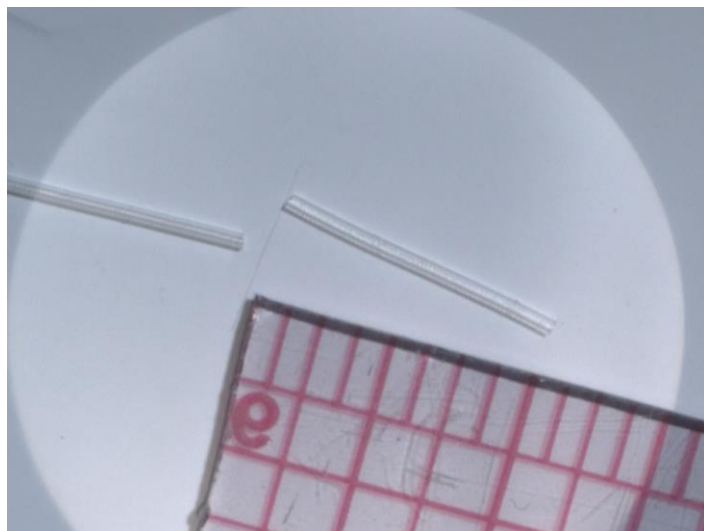
15. Cut off two more lengths of wires for EMG electrodes.

- Do not strip the ends to be implanted; they will be stripped during surgery before implantation.



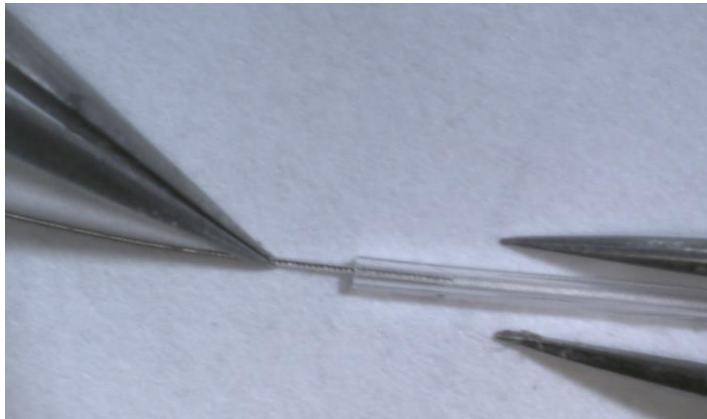
16. Cut off ~13 mm piece of small silicone tubing

- The size of the small tubing depends on what else is being mounted on head. Small tubing used if restraining screw is being implanted; otherwise tubing can be larger



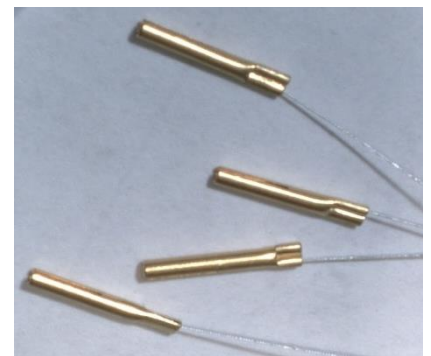
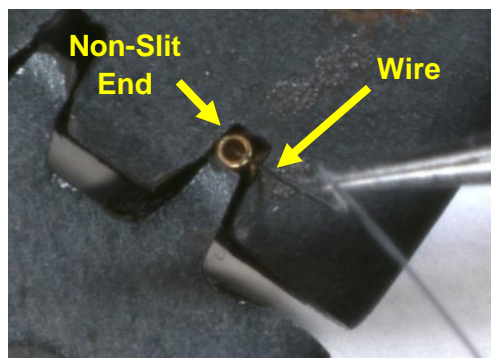
17. Feed the two EMG wires into small tubing until the wires are halfway through. Then, feed through the two long wires of the nerve cuff.

- One side should have the nerve cuff and two EMG wire ends. The other side should have four free wire ends.

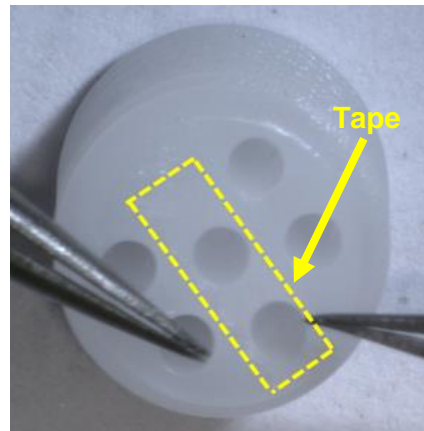


18. Strip ~4 mm of wire at the free end. Bend each stripped wire end in half. Now, crimp a gold pin onto each of the four free wire ends. Do this by first inserting the pin in the crimping tool with the non-slit end facing out. Insert the bent wire 2 mm into the non-slit end and apply pressure to the crimping tool.

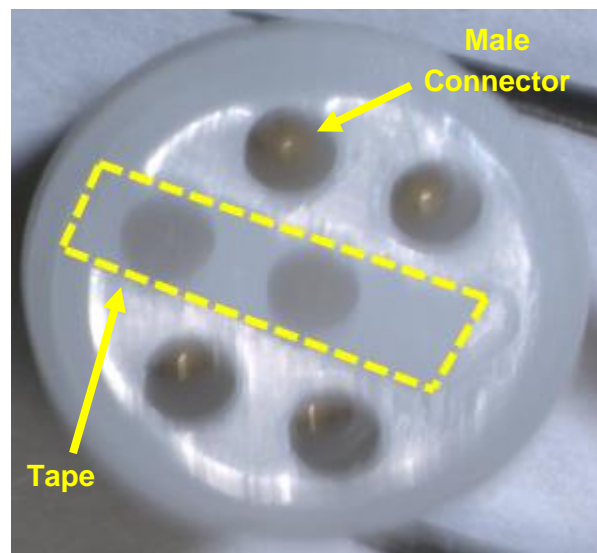
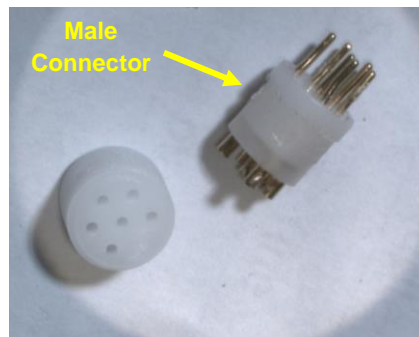
- Gently try to pull the wire back out. If there is resistance, then the crimp was successful.
- If the wire slips, use small pliers to complete the crimp.



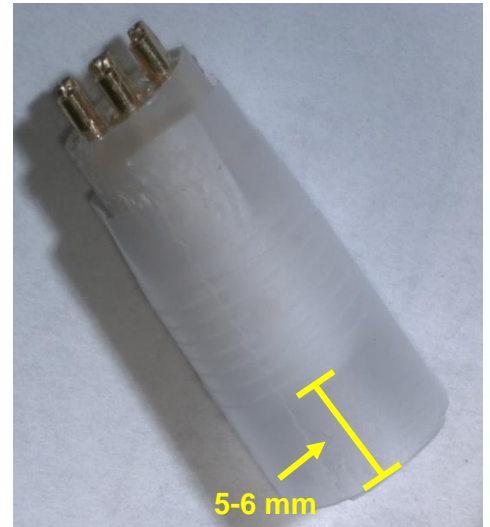
19. Orient the plug so that the side with the smaller holes faces down. Cut out a small piece of tape and cover the center two holes.



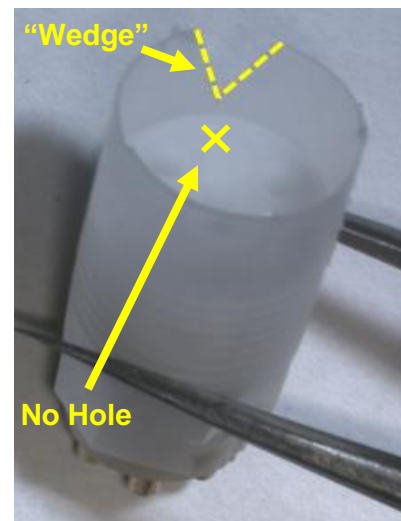
20. Insert the pins of the male plug into the other side of the socket (i.e., the side with the smaller holes).



21. Wrap both the plug and connector in “Scotch” tape and have 5-6 mm of tape stick above the plug to form a mold.

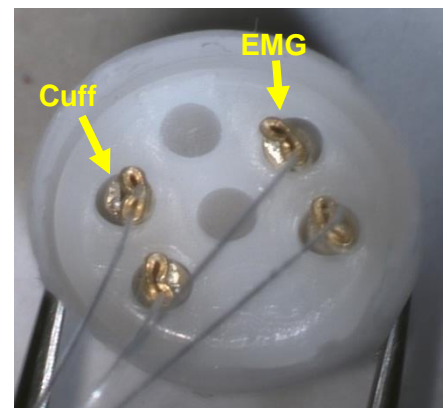
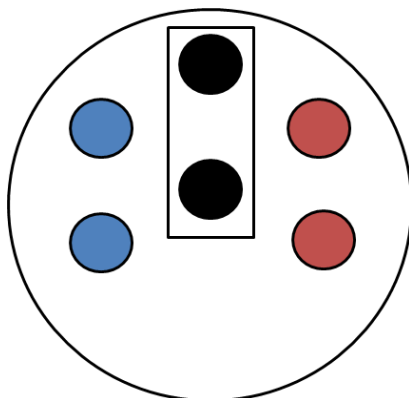


22. Cut out a small wedge in the tape mold across from the two middle holes

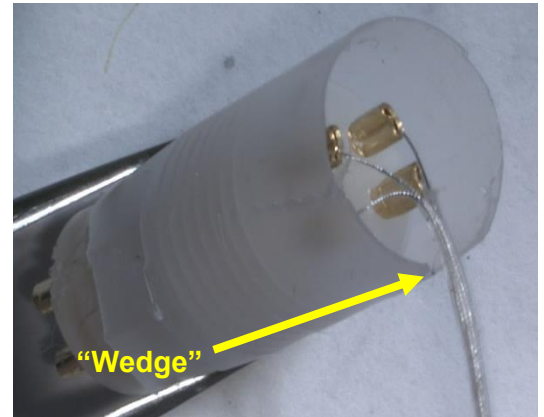
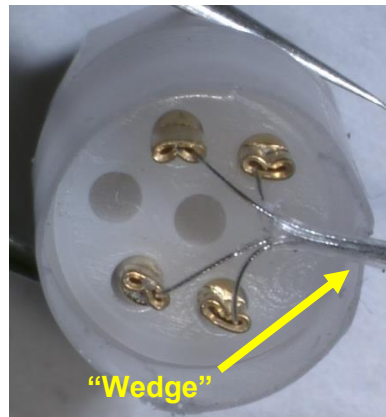


23. Insert the EMG pins on the right side and insert the cuff pins on the left. Make sure the pins are as far into the holes as they can be.

- Blue = Cuff pins
- Red = EMG pins

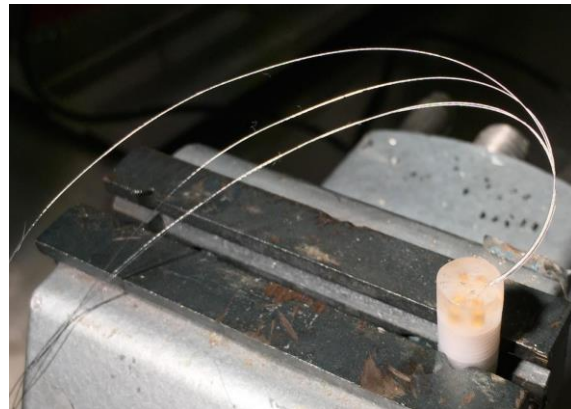
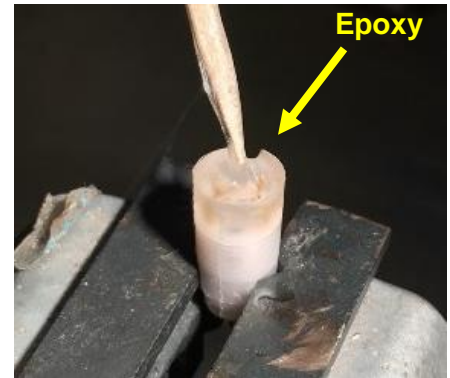


24. Move the small tubing up close to the pins. Place the tube in the small triangle that was cut out; the tube should be ~2 mm inside of the mold.

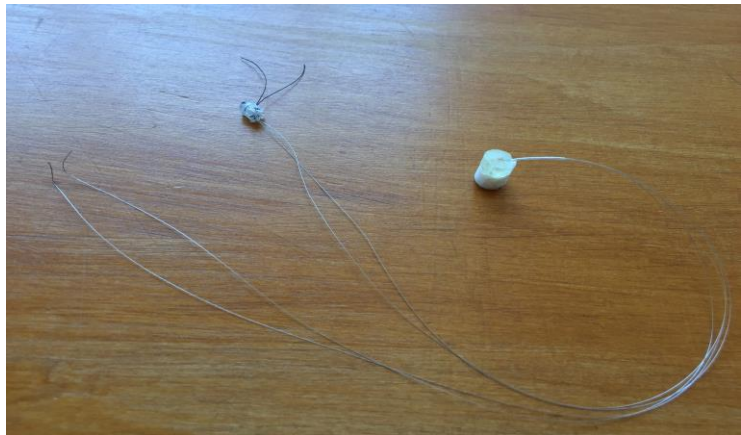


25. Insert the plug/pin assembly into a clamp to secure while the epoxy is added. Mix the 2-part epoxy with a toothpick and apply to the plug until it is flush with the top of the mold. Allow to dry overnight (or for at least 2 hours before removing).

- If air bubbles form in the mold use the toothpick to remove them



26. When the epoxy is dry remove the plug from the clamp. Remove the tape from the outside of the plug with forceps. Clean in alcohol and sterilize before use.



MATERIALS (CUFF)

- multi-stranded stainless steel wire, Teflon-insulated (e.g., Cooner Wire AS631)
- Silicone rubber tubing (Silastic), 0.078" ID x 0.125" OD
- 6-0 silk suture
- Instant adhesive (e.g., Superglue, Loctite 404)
- Biocompatible adhesive (e.g., Silastic Medical Adhesive from Dow-Corning)
- Toothpicks (3-4)
- 27- or 30-ga needle
- Fine straight forceps (#5 style)
- Fine 45° angled forceps (#5 style)
- Hemostat or needle driver
- Scissors, fine
- Razor blade
- Ruler

MATERIALS (HEAD MOUNT):

- Crimping tool
- Connector pins (e.g., Plastics One E363/0)
- Socket (e.g., Plastics One MS363)
- Male plug (e.g., Plastics One 363/CP)
- Silicone rubber tubing (Silastic), 0.012" i.d. x 0.025" o.d.
- 5-minute epoxy
- Scotch tape
- Vise (or other clamp)