**Spinal cord stimulation**

Cervical placement:

- cervical enlargement: insert the electrode at T2-3 or T3-4   
- target level for the electrical contacts: C3-6

Lumbar placement:   
- lumbar enlargement: insert electrode at L1-2 or L2-3  
- target level for the electrical contacts: T8-12

\* Placement where the spinal cord is of small caliber may result in unpleasant local segmental effects

- The patient is placed in the prone position with biplanar fluoroscopy  
- Several centimeters of the lead should lie in the epidural space to stabilize the electrode and minimize migration.   
- This is best accomplished by entering the spine at least two segments below the target stimulation level.   
- The technique for insertion uses a Tuohy needle to gain access to the epidural space.

- The epidural space may be identified through the loss-of-resistance method.   
- It is important to identify subarachnoid placement of the needle as opposed to epidural placement  
- Of course, the appearance of CSF will indicate violation of the dura.   
- In the absence of CSF flow, a guidewire or the electrode inserted into the subarachnoid space will glide more easily, and the wire may be seen to “float” in the CSF on fluoroscopy.   
- Finally, electronic stimulation within the subarachnoid space will elicit stimulation response at extremely low thresholds.

- When the epidural space has been identified, the electrode may be advanced through the Tuohy needle to the appropriate stimulation position.   
- Care should be taken to recognize whether the electrode has migrated ventrally (indicated on AP fluoroscopy by slight lateral deviation followed by medial curvature).   
- Lateral imaging may be useful in determining this, as well.

- The electrode should be secured with multiple points of fixation to reduce the chance of dislodgement.   
- Strain relief loops may be used around the insertion site to deflect tension away from the trajectory of the electrode.   
- Anchors and nonabsorbable suture are used to fix the electrode to the interspinous ligaments and to the fascia before tunneling toward the generator.

- Similarly, the paddle electrode is placed with the patient in the prone position.   
- A fluoroscope is positioned anteroposteriorly, and the vertebral level is identified.   
- Following generous administration of local anesthetic, a midline incision is made over the interspace through which the electrode will be placed. - Unlike the percutaneous **technique**, the level of entry in paddle electrode placement is usually only one or two segments below the level of planned stimulation.   
- The paraspinous muscles are cleared from the spinous processes and lamina bilaterally, the inferior portion of the cranial lamina is resected, and the ligamentum flavum is carefully removed.   
- The epidural space is explored cranially to ensure there are no adhesions, and the electrode is placed under visual and anteroposterior fluoroscopic guidance.   
- Often at this point, a trial of stimulation is performed to ensure good coverage of the patient’s pain.   
- When final placement is determined, the leads are secured to the interspinous ligament, and the fascia is closed.   
- Much like with percutaneous leads, strain relief loops are made in the subcutaneous space, and the leads are tightly secured to the fascia.

**Generator Placement**

- Internal pulse generators are implanted in a subcutaneous pocket in a position where they will not interfere with bony prominences.   
- Two common locations are the lower quadrant of the abdomen or the buttock. It is important to consider the ease of the patient to access the generator for routine programming.   
- Also, care should be taken to avoid placing the generator where undue pressure will be placed on it, causing skin breakdown from waistbands or sitting.   
- Some practitioners advocate placing a generator in the region of the buttock because it is more convenient **surgical**ly and is cosmetically acceptable to most patients.   
- However, there are data indicating that such generator placement increases the strain on the leads, increasing the propensity for lead migration or fracture.

- In preparation for tunneling and generator placement, it has been our practice to close the midline **spinal** incision and place the patient in the lateral position under general anesthesia.   
- Any trial leads exiting the skin are disconnected from the generator and are cut close to the skin.   
- The patient is prepared and draped, and the subcutaneous pocket is created.   
- The back incision is then reopened, and an extension lead is tunneled subcutaneously between the two incisions.