Spinal Tumor Surgery (techniques)

INTRAOPERATIVE TUMORS

Intrathecal steroids and mannitol in severe cases

Monitoring: Approach, Dura, Cord, Tumor, Closure, Special situations

Special situations

1) Possible ischemia or retraction injury

2) Monitor spinal cord

3) Holocord tumors

POSTOPERATIVE: Prognosis

Total removal with preservation of neurologic function!

PREOPERATIVE

• Steroids in perioperative period (start at least 24 h prior to surgery; begin tapering 3-5 days after surgery)

• Baseline urodynamic studies!

• Do we repair VA balloon occlusion test if anticipate vertebral artery sacrifice; if VA is nondominant, may one consider sacrificing (e.g. coiling) VA preop.

PROCEDURE

These are high-risk operations that require special expertise in spine and microsurgical techniques.

• It is sometimes recommended to have two surgeons in this operation (or an experienced assistant).

MONITORING

Monitor spinal cord function using intraoperative electrophyisology (real-time feedback regarding possible ischemia or retraction injury):

1) Somatosensory-evoked potentials (SSSEP)

2) Motor-evoked potentials (MEP)

3) D-scores

4) ECG (extremity muscles, anal sphincter)

– spinal cord is sensitive to decreased perfusion - avoid hypotension (keep MAP > 85!)

See p. 125 (including protocol for intraop spinal cord injury)

Epidural recording for D-wave correlates with expected outcome. See p. 125

APPROACH

- Depending on tumor location – either laminectomy (posterior approach) or corpectomy (anterior approach)

• Patient under general anesthesia (TIVA – to allow monitoring) in prone position

• If tumor spans several spinal levels → wide laminectomy (laminoplasty* in children and select adults)

• Removing all lamina as single unit en bloc with footprint (“lobster tail”) → at the end place back and suture to the facet/pars with silk sutures (drill bone holes at the end place back and suture to the facet/pars with silk sutures)

– Removing all lamina as single unit en bloc with footprint (“lobster tail”)

– Doing this maneuver will help rotating the cord to gain further access to the lesion

– Laminectomy should be of sufficient size to allow visualization of healthy cord above and below neoplasm.

– When using a posterior approach for ventral and lateral lesions, the spinal cord can be released by cutting the dentate ligament bilaterally at the level of the lesion, above and below - this maneuver will help rotating the cord to gain further access to the lesion

DURA

• Prior to dural opening, tumor is localized with intraoperative ultrasound or spinal stereotaxy.

• Perfect hemostasis before opening dura (epidural bleeding only tends to get worse once dura is opened); wax bone edges then lay 0-5-3 sutures along gutters to absorb blood ooze

• Open dura under microscopic magnification

• Midline durotomy extending above and below the level of the lesion as confirmed by intraoperative ultrasound

• Be mindful of potential adhesions of the spinal cord or vascular structures to the undersurface of the dura – operating on previously resected or radiated tumors may present a special challenge - err on the conservative side so as not to compromise spinal cord function

• Place 4-0 silk tucks to retain dura open

CORD

Under microscope, linear* midline**, myelotomy at thinnest area between tumor and spinal cord.

*To spare vertically running white matter tracts.

**Between the sensory fibers

Eccentric lesions may be approached through posterior intermediate sulcus or dorsal root entry zone (posterosalateral sulcus)
• dorsal midline must be studied carefully to identify the median raphe so that injury to the posterior columns is avoided.
  - pattern of the dorsal roots can help with this identification.
  - visualizing the adjacent normal cord and follow midline raphe across the tumor (some tumors may be growing further in one hemi-cord than the other and may actually rotate or shift the dorsal midline); dorsal median vein is another landmark.
  - electrical mapping of the posterior columns is also helpful - stimulate with bipolar fork where it is safe to cut.
    - if tumor has exophytic component, this is initial area of approach (pia mater is opened directly over tumor), i.e. debulk any exophytic component prior to addressing tumor located within parenchyma.
• dorsal vasculature is saved by dissecting it from the pia and rotating it to one side of the spinal cord.
  - blood vessels crossing the dorsal midline or penetrating into the dorsal midline are coagulated with fine bipolar forceps on the lowest coagulation setting; do it in strict midline! Dr. Jallo cautions to minimize coagulation until cord is opened.
• use #11 blade
  - Dr. Nader recommends double-edge razor blade - sharper than most scalpels.
  - Dr. Jallo uses 16G needle.
• exposure is opened until full extent of lesion can be visualized (ultrasoundography may help to define tumor extent).
• dissect pia and place 5-0 or 7-0 Prolene stitches (to keep myelotomy open) suturing edge of pia to edge of dura (may place vascular Weck clips instead of tying knots).
  * Dr. Jallo recommends no pial stitches (so cord can relax in areas where surgeon is not working); he uses plated bayonets to spread the cord.
• traction on the cord should be avoided and kept to a minimum at all times.

**TUMOR**
• besides histology, tumor edema and no motor deficits are predictors of GTR.
• try to find cleavage plane to dissect tumor around; nonvascular tumors can be removed in piecemeal fashion (vascular tumors - en bloc).
  *Rhoton dissectors, Beaver blade, sharp canal knives, microbipolar cautery, and Fukushima microsuctions - use #6 Rhoton dissector to sweep the border along with very gentle traction on the tumor with a fine-toothed forceps McCabe Canal Knife:

• defining the plane of dissection between the tumor and the cord can be difficult (preoperative T2-weighted MRI must be thoroughly studied to identify the cyst-tumor junction that can be used to begin the dissection between tumor and spinal cord).
• upon entering lesion, send biopsy for histopathology.
• tumors tend to be avascular and may have true capsule (or definable plane).
  - if ill-defined plane is present, risk-to-benefit ratio for aggressive removal is not clear (e.g. developmental tumors can be quite adherent to spinal cord).
  - for biopsy-proven high-grade lesions, only biopsy and dural patch graft (to enlarge space for spinal cord) may be alternate approach to attempted resection.
  * rapid progression even after aggressive resections

**EPENDYMOMAS** have plane – easy to dissect; blood supply to the ependymoma arises from the branches of the anterior spinal artery penetrating through the ventral median raphe - these vessels are coagulated and divided as they are encountered on the ventral surface of the tumor.
ASTROCYTOMAS do not have plane (tumor cells infiltrating among axons of the spinal cord - debulk, i.e. resection is limited to the portion of the tumor that can be clearly defined as distinct from normal cord; in cases of cord compression, where the astrocytoma needs to be debulked, portions of the tumor can be resected, which are usually discolored (i.e., gray or yellow) relative to the whiteness of the spinal cord (consistency tends to be different as well, and discerning this can require some tactile feedback gained by the experience of the tumor neurosurgeon); if uncertainty arises during resection, further very tiny tissue specimens may be sent to pathology for spinal cord versus tumor differentiation.

- if frozen section shows tumor to be malignant → surgery is aborted (→ radiotherapy).

N.B. extent of resection must be based on combination of presence of plane-of-dissection and intraoperative neurophysiological monitoring data; plus, surgeon’s experience and patient’s wishes!!

- debulking instruments: NICO Myriad side-cutting dissector, Cavitron ultrasonic surgical aspirator (CUSA), fine-tipped contact laser (CO₂, KTP).
- any cysts/syringes encountered should be drained, septations divided (spinal cord pulsations demonstrating adequate decompression are monitored).
- for hemostasis use irrigating bipolar cautery (e.g. MALIS), irrigation and absorbable gelatin sponge with thrombin.
- any vessels en passage should be spared.
- when operating on tumors of conus medullaris, filum terminale should probably also be removed.

**SPECIAL SITUATIONS**

**HOLOCORD TUMORS**

- typically, low grade tumors.
- Dr. Jallo operates on upper end of tumor (to decompress arm area) and then chemoradiation for the rest of tumor.