Spinal Tumor Surgery (techniques)

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INTRAMEDULLARY TUMORS

Surgical extirpation is treatment of choice for benign tumors! (cures have been reported only after complete surgical resections)

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!

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).

TECHNIQUES

- Monitor spinal cord function using intraoperative electrophysiology (real-time feedback regarding possible ischemia or retraction injury).
- cord irrigated with warm normal saline ± papaverine.
- any retractors should be loosened; look at the entire operative field to verify that there are no impinging factors on the spinal cord.
- increase blood pressure.
- verify the depth of anesthesia, presence of hypertension or hypothermia.
- transfuse blood if needed.
- give additional steroids.
- if nothing helps, terminate surgery (consider expandable duraplasty to allow for cord swelling).

APPRAISAL

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

Posterter approach

- patient under general anesthesia (TIVA – to allow monitoring) in prone position.
- if tumor spans several spinal levels → wide laminectomy (laminoplasty* in children).
- *removing all lumbar as single unit or with footplate (‘lobster tail’) → at the end place back and suture to the facet/pars with silk sutures (drill bone holes with C bit) - to protect spinal cord, to lessen risk of subsequent spinal deformity.
- – laminectomy should be of sufficient size to allow visualization of healthy cord above and below neoplasia.
- when using a posterior approach for ventral and lateral lesions, the spinal cord can be released by cutting the denticulate 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

- need dry field - wax bone edges, lay 3x1 in patties along 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); then lay 0.5x3 patties along pattern to absorb blood ooze.
- open dura under microscopic magnification.
- 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 4-5 silk tuck-ups to retain dura open.
- duratomy is performed in the midline extending above and below the level of the lesion as confirmed by intraoperative ultrasound.

CORD

Under microscope, linear* medullary** myelotomy at thinnest area between tumor and spinal cord.
- to spare vertically running white matter tracts.
- *between the sensory fibers, efferent tracts may be approached through dorsal root entry zone

- 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.
- visualize the adjacent normal cord and follow midline raphe across the tumor (some tumors may be growing further in one hemisected than the other and may actually rotate or shift the dorsal midline).
- 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 dural midline or penetrating into the dural midline are coagulated with fine bipolar forceps on the lowest coagulation setting.

- use #11 blade (Nader recommends double-edge razor blade - sharper than most scalpels).
- exposure is opened until full extent of lesion can be visualized (ultrasonography 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).
- traction on the cord should be avoided and kept to a minimum at all times.

**TUMOR**

- 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 Fukusima microsections - use #5 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 (prooperative 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 punch 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.

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**TECHNIQUES**

- if frozen section shows tumor to be malignant → surgery is aborted (→ radiotherapy).
- 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 venous return passage should be spared.
- when operating on tumors of conus medullaris, filum terminale should probably also be removed.

**CLOSEDNESS**

- defect in neural tissue does not need to be closed, alternative - approximate myelotomy edges with Prolene (but leave gaps – to prevent intramedullary hematomas).
- watertight dural closure is necessary (may use dural grafting, tissue adhesives over suture line) to minimize formation of pseudomeningocele or CSF leak
- irrigate intradurally – leave no blood.
- simple running 4-0 silk / 5-0 Prolene suture (ideally, Hemost-Seal / HS 101 needle)
- use #11 blade on the lower coagulation setting.
- irrigation and absorbable gelatin sponge with thrombin
- if frozen section shows tumor to be malignant → surgery is aborted (→ radiotherapy).
- posterior spinal artery penetrating through the ventral median raphe.

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!!!!

**CLOSURE**

- epidural drain may be left in place (but risk of infection or CSF tracking along drain); H: place drain above muscles (to avoid pulling CSF).
- consider instrumentation to prevent postoperative kyphosis.

- for hemostasis use ultrasonography, microbipolar cautery, and microsuctions with very gentle traction on the tumor with a fine-toothed forceps.
POSTOPERATIVE

- see p. Onc.50
- flat for 3 days.

RESULTS


— gross total resection was achieved in 91% of ependymomas, 14% of astrocytomas, and 91% of hemangioblastomas.
— at a mean follow-up of 42 months, recurrences were seen in 7% of ependymoma and 48% of astrocytoma.