

SURGICAL MANAGEMENT OF BRAINSTEM GLIOMA

Brainstem tumor classification systems

Author & Year	Method used to create system
Epstein 1985	CT
Epstein & McCleary 1986	CT, MRI and Surgical Observation
Stroink et al, 1987	CT
Darkovich et al, 1990	MRI
Albright, 1996	MRI
Fischbein et al, 1996	MRI

Brainstem tumor classification systems

Choux et al., 2000

CT & MRI

Type I: diffuse

Type II: intrinsic, focal

Type III: exophytic, focal

Type IV: cervicomedullary

DIFFUSE BSG

□ Diffuse BSG-

- Hypo on T1, hyper on T2, inhomogenous contrast enhancement within or around the tumour.
- Contrast enhancement in only 1/3rd cases.
- No significant difference in prognosis with/without contrast enhancement.

FOCAL BSG

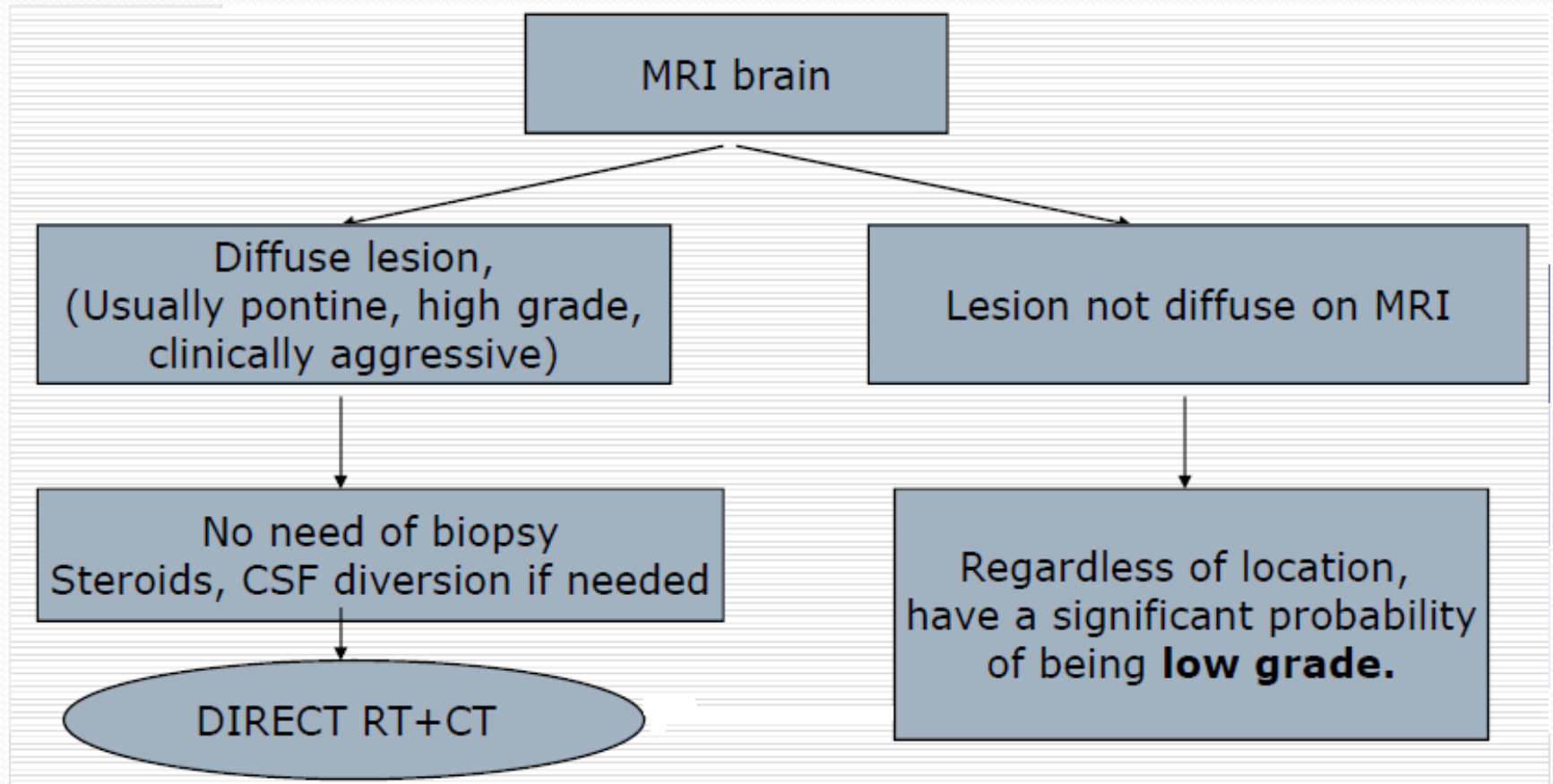
□ Focal BSG

- Well circumscribed, of limited size, may be partially cystic
- Midbrain
>Medulla>Pons
- Hypo on T1, hyper on T2, nidus of focal enhancement
- Usually pilocytic astrocytomas

DORSAL EXOPHYTIC BSG

- Dorsally exophytic BSG-
 - Intra-IV th ventricular tm
 - Resemble vermian astrocytoma with involvement of IV th ventricular floor

Practical decisions regarding treatment of BSG



Intraoperative monitoring

- Cranial nerves-
 - EMG monitoring – III,IV,V,VI,VII, IX,X,XI,XII
 - BAEP – VIII nerve
- SSEP and MEP - tracts

SSEP –

- Monitors Dorsal column integrity
- Stimulation sites UL – Median/Ulnar nerves LL -- Posterior tibial nerve
- ... $\geq 50\%$ decrease in amplitude and associated 10% increase in latency – significant

BAEP

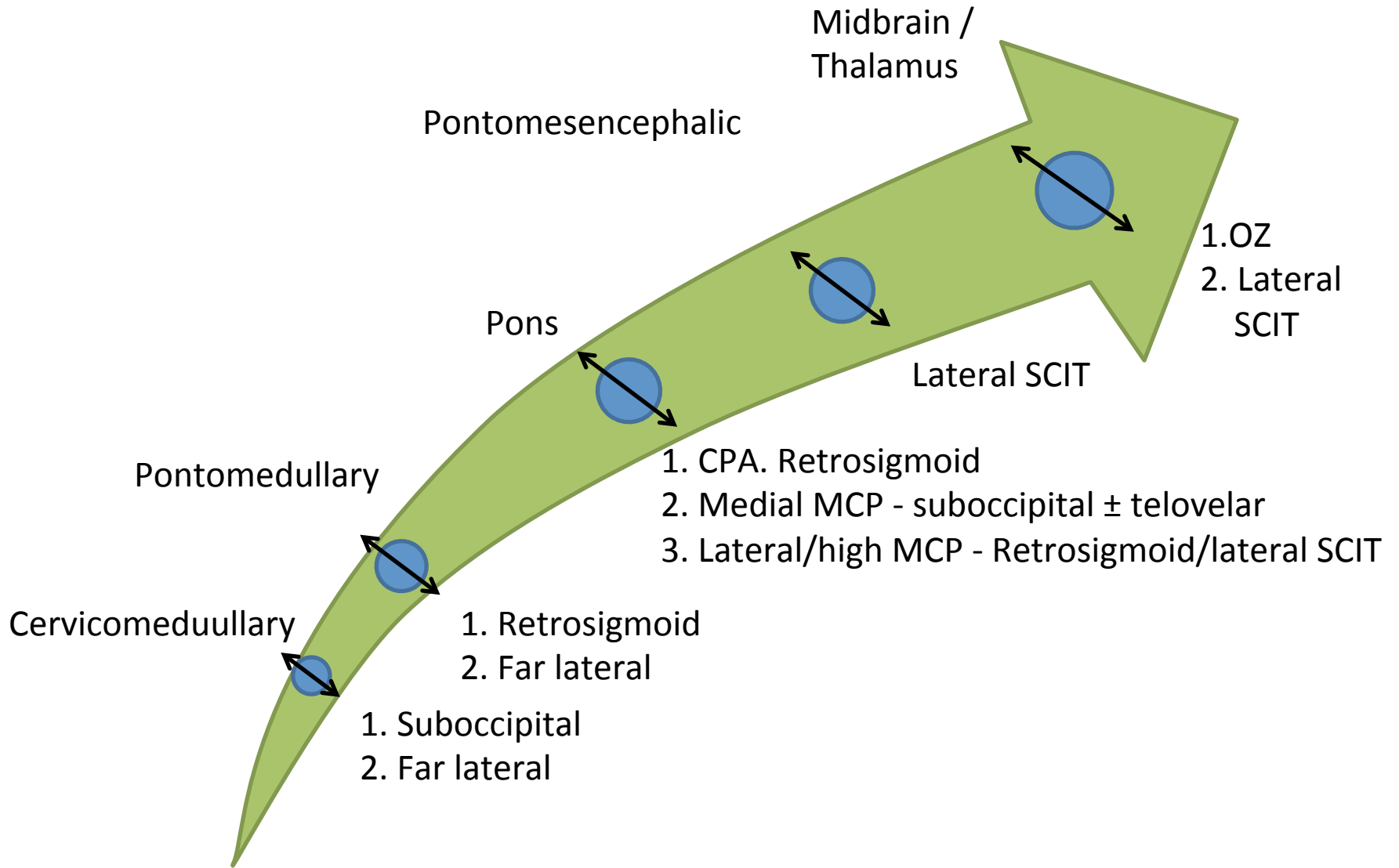
- Representation of electrical activity generated by the eighth cranial nerve and brainstem in response to auditory stimulation.

BAEP

- Wave V is the most reliably seen wave
- A shift in latency of 1 millisecond or a drop in amplitude of 50% could be significant.
- changes occur, may be due to improper retraction on the cerebellum and brain stem.
- Reversible with change of position of the retractors

Choice of approach

- Location of lesion
- Area to which lesion come close to pial surface
- Clinical status of patient
- Comfort of individual surgeon



Planned approach for ventral lesions

Ventral / lateral

rostral to cranial nerve V
Between lower nerve and cranial
nerve V
Caudal to lower group

Transsylvian / subtemporal
Presigmoid / retrosigmoid

Far lateral

CHEN ET AL- NEUROSURGERY
VOLUME 68 I NUMBER 31 MARCH 2011,

Planned approach for dorsal lesions

Dorsal

Midbrain

Suboccipital transtentorial/

supracerebellar infratentorial

Floor of fourth ventricle

Transcerebellomedullary fissure

Medulla

intertonsillar

CHEN ET AL - NEUROSURGERY

VOLUME 681 NUMBER 31 MARCH 2011,

Safe entry zones to brainstem - Rationale

- The 2-point method was used as an objective means to choose the surgical approach
- One point is placed in the center of the lesion, and a second point is placed either where the lesion comes closest to a pial surface or at the safest entry point into the brainstem.

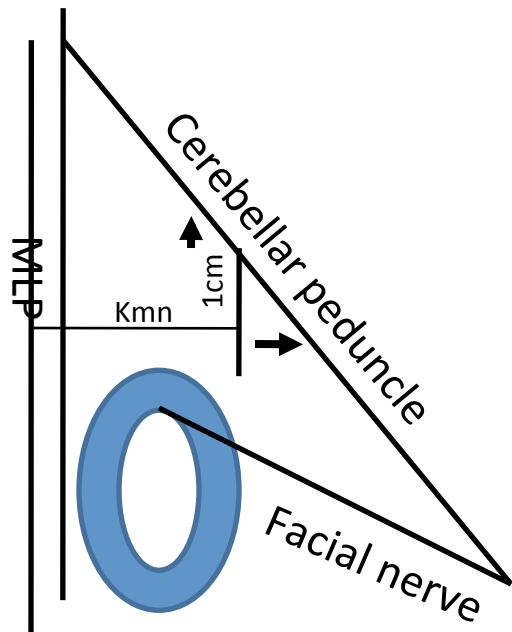
PONS

- Ventral and ventro-lateral pons approached by
 - Retro Sigmoid approach
 - Pre sigmoid approach
 - Trans petrosal approach

Safe entry zone for ventro lateral pons

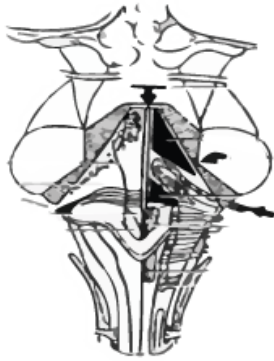
- Peritrigeminal zone between emergence of fifth and seventh nerve located medially to fifth and lateral to pyramidal tract.
- Fibers are directed horizontally so myelotomy should be in horizontal direction.
- Surgical window –
 - ❑ Horizontal – 4.64mm (3.8 – 5.6 mm)
 - ❑ Vertical - 11.2 mm (9.5- 13.1mm)

Suprafacial Triangle

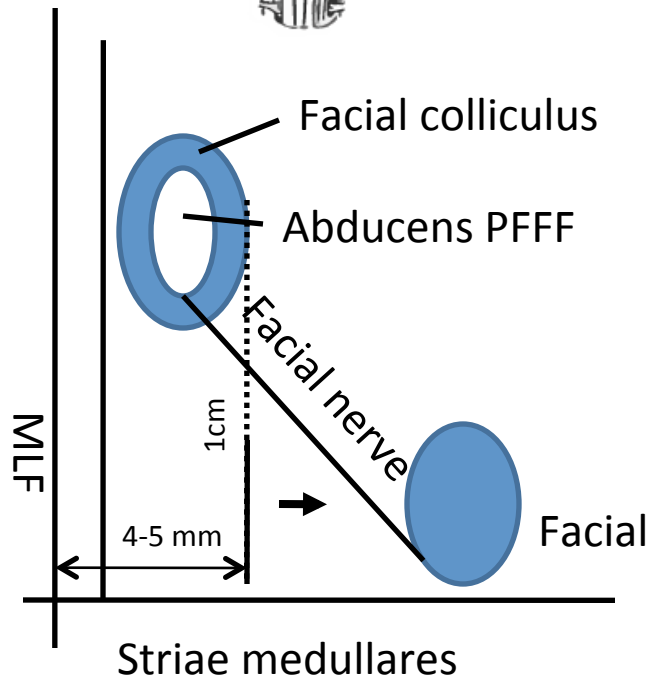


- 1 cm longitudinal incision from edge cerebellar peduncle and 5mm lateral to median sulcus
- Length of incision – 7mm

Kyoshima K, Kobayashi S et al. A study of safe entry zones via the floor of the fourth ventricle for brain-stem lesions. Report of three cases. JNS 1993



Infrafacial Triangle



1 cm longitudinal incision
above striae medullaris
and 5 mm lateral to
median sulcus

Kyoshima K, Kobayashi S et al. A study of safe entry zones via the floor of the fourth ventricle for brain-stem lesions. Report of three cases. JNS 1993

Ventral medulla

- Safe corridors –
 - at level of retro olivary sulcus
 - between cranial nerve 12 and C1 at level of anterolateral sulcus
- Surgical window –
 - ❑ cranio-caudal - 13.5 mm
 - ❑ Transverse - 7 mm
 - ❑ antero-dorsal - 2.5mm

Dorsal medulla

- Safe corridors –
 - Posterior median fissure - below obex ,between nucleus of gracile fasciculus
 - posterior intermediate sulcus – between gracile and cuneate fascile
 - Posterior lateral sulcus - between cuneate fascile medially and spinal trigeminal tract and nucleus laterally

Ventral Midbrain

- Safe entry zone – lateral to cranial nerve III , between SCA and PCA and medial to pyramidal tract

Ventro lateral midbrain

- Safe entry zone is lateral mesencephalic sulcus (LMS)
 - Minimum working distance – 4.9 mm
 - Maximum working distance – 11.7 mm
 - Mean \pm SD - 8.2 \pm 1.76 mm

Safe entry zone for posterior midbrain

Structure	Dysfunction
Superior Colliculus	Pupillary disturbance, gaze palsy
Inferior Colliculus	Difficulty in localizing sound in space

Surgical technique-

- Almost all BSTs are dorsally located, therefore should be approached through posterior fossa.
- Position-prone(preferred)/sitting
- Midline skin incision
- Suboccipital craniotomy±cervical laminotomy
- Y –shaped dural opening

Surgical technique-

- Vermis coagulated and split at appropriate level.
- Cerebellum held to the sides using self- retaining retractors (avoid excessive side retraction – pseudobulbar palsy).
- IVth ventricle approached after division of medullary velum.

Tumour decompression

- Conventional suction technique frequently causes brainstem dysfunction manifested by bradycardia & arrhythmia.
- CUSA causes movement of adjacent structures only within 1mm of vibrating tip, allowing extensive and quick dissection adjacent to or within the substance of brainstem.

Surgical technique- Focal tumour

- Rostral & caudal pole of the tumor be completely exposed.
- Incision at an area where tumor is most superficial.
- It also must be away from the midline and at least 1.5cm rostral to the obex - avoids injury to cr. nv nuclei X-XII.
- Incision < 1cm.

Surgical technique- Focal tumor

- Use of plated bayonet(very small plates at the tip) as ‘microretractor’.
- CUSA at a low setting.
- Careful identification of white matter interface.
- Minimal manipulation of adjacent normal tissue.

Surgical technique- Cervicomedullary tumor

- Suboccipital craniotomy + **osteoplastic laminotomy**.
- Expose both rostral and caudal extent of the tumor.
- USG guidance to know extent of tumor prior to opening the dura - entire tumor should be within the confines of the operative exposure.

Surgical technique- Cervicomedullary tumour

- Midline myelotomy
 - 'True' midline to be identified
 - Identify DREZ bilaterally
- If tumor is solid-cystic, myelotomy to be placed first at tumor –cyst junction and cyst is removed prior to tumor excision.
- If tumor is non-cystic, myelotomy where tumor is most voluminous & closest to the pial surface.

Surgical technique- Cervicomedullary tumour

- Myelotomy to be terminated 1 cm proximal to the caudal pole of the tumor → tumor is least voluminous here, removed by gradual upward dissection.
- At the rostral pole, tumor invariably subpial and bulging posteriorly at the obex.

Surgical technique- Cervicomedullary tumour

- USG to guide the extent of tumor excision- to confirm bulk of tumor is removed.
- Don't chase small questionable fragments.
- If deterioration of SSEP/MEP during the procedure, interrupt the dissection and move to another area.

Surgical technique-Cystic tumour

- Bulge into the IV ventricle.
- “Collapse” of the cyst cavity and surrounding neural tissue following cyst evacuation → difficulty in identifying the solid nodule.
- ‘Hand-held’ retractor compared to fixed.
- Avoid frequent manipulation of retractor.

Surgical technique- Dorsally exophytic tumor

- Major technical complication-injury to neural structures immediately below the ependymal lining.
- Remove tumor “flush” with the floor of IV ventricle
- Do not pursue tumor inside the brainstem.
- Facial colliculus injury

Peri & post-operative care

- Perioperative steroids(methylprednisolone)
- Elective ventilation for at least 48 hours
- Mechanical ventilation till recovery of ventilation & normal cough reflex
- LCN paresis- NG/feeding gastrostomy
- V,VII nv paresis- temporary tarsorrhaphy
- Good nursing care
- Physiotherapy
- Post-op brainstem injury mostly reversible if surgical technique is proper

Role of stereotactic biopsy

- Majority of focal, dorsally exophytic and cervicomedullary BSG are benign and resectable by direct surgery with low morbidity and good outcome.

New york symposium on Brainstem surgery, 1996.
Epstein, Constantini ,Hoffman, A Bricolo

Role of stereotactic biopsy

- Reserved to
 - When the diagnosis is uncertain, to rule out inflammatory pathology like TB.
 - Focal intrinsic endophytic lesion- well limited masses within the brainstem surrounded by neural tissue and therefore do not reach the surface.

Role of GKRS

Yen CP, Sheehan J, Steiner M, Patterson G, Steiner L.
Gamma knife surgery for focal brainstem gliomas.
J Neurosurg. 2007 Jan;106(1):8-17.

- 20 patients
- 10-18 Gy
- Median follow up- 78 months
- Tumor disappeared in 4 pts, decreased in size in 12 pts
- Minimal peri & post- procedural morbidity

Journal quotes

- ”An aggressive surgical approach to patients with intrinsic brainstem tumors significantly improves overall survival(OS) and progression free survival (PFS) compared to adult non-surgical series.”
- (OS) rate is 61% and progression free survival (PFS) is 45% at 5 years.

Neurosurgery:

August 2012

doi: 10.1227/01.neu.0000417806.84351.f0

Take home message

- Knowledge of safe entry zones.
- Diffuse tumor almost invariably malignant and should not be operated upon → Direct RT + CT
- Focal lesions : If laterally located & appears to be approachable with acceptable risks, resection is appropriate.
- Radical excision possible
- If more centrally located → Stereotactic biopsy + Irradiation



Thank You