Adult Brain Tumours: 
an approach based on imaging findings

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Learning objectives:

• Learn imaging characteristics of adult brain tumours
• Formulate basic differential diagnoses based on these imaging features
• “pearls of wisdom” for image interpretation that can lead to specific diagnosis
Disclosures, acknowledgements

• No disclosures...
• Many acknowledgements!
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• Faculty/fellows UCalgary Neuroradiology, (particularly James Scott)
• UCSF Neuroradiology/Neuropathology
~1/2 of tumours in adults are metastatic!
Intra-axial vs. extra-axial

- CSF cleft
- Widened CSF space/cistern adjacent to lesion
- Intervening pial vessels
- Buckling of cortex
- +/- ”claw sign”
- “dural tail”
- Bony changes
- Note: pituitary and pineal tumours are extra-axial (also cranial nerve schwannomas)
- Intraventricular masses – distinct category or considered intra-axial
38 y female with severely increased headache, 1-2x/d x 1/12 + caffeine use (Pepsi - 2-3L/d x 1 yr).
MR/CT imaging of meningiomas

- T1W iso-hypointense, T2W iso-hyperintense (hyperintensity may correlate with softer tumor)
- Assess for brain invasion, brain edema
- Intense enhancement
- Dural tail – neoplastic infiltration vs. non-neoplastic meningothelial proliferation, hyper-vascularity
- CT for bone changes – infiltration, hyperostosis
Local tumour spread – in the brain

• Astrocytoma
  • Infiltrative
  • White matter tracts
  • Do not respect lobar boundaries

• Ependymoma
  • “plastic” spread through ventricular system
Huge tumour, little mass effect

- Low grade glioma/gliomatosis
46F, rule out lesion
WHO 2016

- Gliomatosis cerebri deleted as a distinct entity
- It is a growth pattern, found in many different gliomas
- Growth pattern = three or more cerebral lobes, frequently bilateral, infratentorial extension
Small tumour with lots of mass effect/edema

- Metastatic (but make sure it’s not an abscess)
Metastatic adenocarcinoma
Restricted diffusion, pyogenic abscess
Tumour spread

• Full anatomical extent
• Perineural spread of head and neck tumours
• Leptomeningeal metastases
74 y.o. male, left CN V(I & II) complete sensory loss, remote cheek SCCa
Subarachnoid spread of tumours

- Metastases from non-CNS primaries
- GBM
- Lymphoma
- Ependymoma
- Choroid plexus tumours
- PNET (medulloblastoma, pineoblastoma)
54F extensive leptomeningeal disease, breast cancer
“plastic” spread: Ependymoma
Tumour that “spills”: CRANIOPHARYNGIOMA
Tumours that cross the midline

- Meningioma
- GBM
- (radiation necrosis)
- Primary CNS lymphoma
- Epidermoid cyst
- (tumefactive MS)
Glioblastoma Multiforme

- Rapidly enlarging malignant astrocytic tumor characterized by necrosis and neovascularity
- WHO grade IV
- Most common primary brain tumor
- Supratentorial white matter most common
  - Frontal, temporal, parietal
  - Occipital lobes relatively spared
  - Cerebral hemispheres > brainstem > cerebellum
- Peak 45-70 yrs
- Relentless progression (death in 9-12 months)
Glioblastoma Multiforme

- **Neuroimaging:**
  - Thick, irregular-enhancing rind of neoplastic tissue surrounding necrotic core
  - Tumor typically crosses WM tracts to involve contralateral hemisphere
  - Rarely may be multifocal or multicentric
  - Necrosis, cysts, hemorrhage, fluid/debris levels, flow voids
  - MRS: ↓ NAA; ↓ myoinositol; ↑↑ choline, lipids & lactate

  - Corpus callosum involvement may be seen in GBM, lymphoma, are rarely metastases & demyelination
  - Viable tumor extends far beyond signal abnormalities
Solitary vs. multiple lesions

• Primary distinguishing characteristic for primary vs. metastatic lesions
• Primary brain tumours can be multicentric (high grade and low grade gliomas)
Brain tumours in the phakomatoses

- NFI – optic pathway gliomas, astrocytoma
- NFII – meningiomas, ependymomas, schwannomas
- Tuberous sclerosis – SEGA
- Von-Hippel Lindau – multiple hemangioblastomas
26F, multiple cranial neuropathies
NF 2: IMAGING

• Bilateral **enhancing CPA-IAC masses**
  – Ovoid when small; "ice cream on cone" when large enough to fill IAC & CPA

• **CNS**
  – Calcifications: Choroid plexus, cerebellar hemispheres, & cerebral cortex
  – Other meningiomas & schwannoma (CN3-12)
  – Ependymomas >> gliomas

• **Spine**
  – Meningiomas, schwannomas, & ependymomas
PATHOLOGY

• Autosomal dominant disorder
• Mutation of NF2 gene chromosome 22
• 50% result from new dominant gene mutation
Cortical based tumours

- Ganglioglioma
- DNET
- Oligodendroglioma
• 20 yo female. Suspected absence seizures. ? organic etiology of episodes.
DNET

- Dysembryoplastic neuroepithelial tumour
- Hx – longstanding partial complex seizures in child/young adult
- Benign mixed glial-neuronal neoplasm
- Frequent association with cortical dysplasia
- Wedge shape, “point” toward ventricle
- Mesial temporal most common location
- Well demarcated, non-enhancing, little or no mass effect/edema
- Cystic, bubbly appearance on T2W
- Surgical resection usually curative
Fat, calcification and cysts

- Fat = very limited ddx
  - Lipoma
  - dermoid
37 year old male

History of seizures
LIPOMA

- Mass of mature non-neoplastic adipose tissue
- Congenital malformation
- Midline location common, 80% supratentorial
- 40-50% interhemispheric fissure
  - Two kinds of interhemispheric lipoma
    - Curvilinear – curves around CC, splenium
    - Tubulonodular – bulky mass, may calcify associated CC agensis/dysgenesis
- T1 hyperintense
- Chemical shift artefact on T2
DERMOID CYST (RUPTURED)
DERMOID CYST (RUPTURED)
calcification

• Intra-axial:
  • Gliomas – “old elephants age gracefully” – oligodendroglioma (almost all), ependymoma, astrocytoma, GBM
  • Other – metastases, choroid plexus tumours, ganglioglioma

• Extra-axial:
  • Meningioma
  • Craniopharyngioma
  • Chordoma
  • Chondrosarcoma
Anaplastic Oligodendrogliaoma
73M sleepy/tired, memory impairment
Craniopharyngioma

• Arises from remnants of Rathke’s pouch
• Primarily suprasellar, can be quite large and “spill” out of the sellar region – middle and anterior fossa, prepontine
• Adamantinomatous most common
• Cystic/solid but mostly cystic, “machinery oil”
• Bimodal = 5-10, 50-60 years
• Visual symptoms
• Slow growing but tend to recur
Craniopharyngioma Imaging

• CT “rule of 90’s” – 90% cystic/solid, 90% Ca++, 90% enhance
• MR appearance variable depending on cyst contents
• Multiple cysts common and may have different signal
• Hypo-hyperintense on T1, hyperintense on T2
• Nodule often calcified and hypointense on T2
• Cyst walls and nodules enhance
Relatively dense (CT)/hypointense T2 tumours

• Correspondence with reduced diffusion
• Lymphoma
• PNET
• Solid part of GBM
PRIMARY CNS LYMPHOMA
PRIMARY CNS LYMPHOMA
Tumours that characteristically have cystic components

- Intra-axial
  - GBM
  - Hemangioblastoma
  - Ganglioglioma, DNET, PXA

- Extra-axial
  - Craniopharyngioma

- Non-neoplastic
  - Dermoid/epidermoid

- Beware of mimics!
Hemangioblastoma

- Benign and slow growing
- Sporadic or multiple (VHL)
- Most in PF, nodule typically abuts pial surface
- Nodule with peri-tumoral non-neoplastic cyst most common
- They can be entirely solid
- can also have intratumoral neoplastic cyst
- both peritumoral non-neoplastic and intratumoral neoplastic cysts (as in this case)
Hyperintensity T1W (-contrast)

- Hemorrhage
- Calcification
- Proteinacious cyst
- melanin
38-year-old man with progressive decreased vision, ataxia, and pressure-like frontal headache.
COLLOID CYST

- Mucin containing 3rd ventricular cyst
- Hyperdense foramen of Monro mass on unenhanced CT
- <1% other sites (lateral & 4th ventricles, extraaxial)
- 1/3 isointense on T1, 2/3 hyperintense on T1
- Variable T2 signal
- No DWI restriction
- Enhancement unusual
- 90% stable, 10% enlarge
- Acute obstruction may lead to rapid onset hydrocephalus
Metastatic melanoma
Density/Signal intensity similar to CSF

- Epidermoid cyst
- Neurocysticercosis
Epidermoid tumours

- Stratified squamous epithelium, contains keratinaceous debris and cholesterol
- CPA most common, middle fossa, parasellar
- Cerebral convexities less common
- CT hypodense, Ca++ in 25%
- Iso-slightly hyperintense relative to CSF on T1 and T2, slightly heterogeneous
- Do not suppress on FLAIR, restrict on DWI
- Insinuate in/around structures, burrow into brain
Test your skills!

- 45yr/M with h/o Increasing behavioural changes x 3 yrs
ANSWER: IT’S NOT A TUMOUR!

a. Central neurocytoma
b. Meningioma
c. CNS lymphoma
d. IT’S NOT A TUMOUR!!
Giant intracranial aneurysms

- Def.: > 2.5 cm.
- Types: Saccular, fusiform.

Epidemiology and natural history
- Comprise 3-5% of intracranial aneurysms
- Peak age of presentation 30-60 yr
- F:M, 3:1
- 2/3rd Ant circulation 1/3rd Post circulation
- Slow growing with repeated internal hemorrhage

- Laminated thrombus of varying ages

- Symptoms commonly related to mass effect, lower rate of rupture

- Imaging: CT – hyperdense mass with calcification. MRI - Mixed signal intensity mass with thrombus of various stages, Perianeurysm hematoma and edema