Guidelines for follow up imaging of adult patients with tumours of the brain, spine, meninges, crainial nerves or pituitary gland.

Please note that paediatric cases are NOT covered by these guidelines, follow up schedules for paediatric cases will be agreed by the Paediatric Neuro-oncology MDT.

Scan Type

Essential information to be completed on the radiology request to help the radiologist determine the appropriate scan type (see also details in appendix 1):

1. In the *"clinical details"* box:
    - Tumour site
    - Tumour histology including WHO grade if known
    - Previous treatment
        - Date of operation and whether any excision was complete or partial or biopsy only.
        - Whether radiotherapy or chemotherapy was given and when it finished.
        - Inclusion in a clinical trial.
    - Date, type and place of most recent scan.

2. In the *"examination/s required"* box:
    - Brain, C/T/L spine or whole CNS imaging as appropriate.

3. The exact scan protocols to be used depend on the site and nature of the tumour: Please see the ***appendix*** for the scan protocols.

Scan Frequency

The following tables indicate the agreed scan frequency for patients on follow up depending on the histological type and applies to patients with brain or spinal tumours. The follow up time periods in these protocols e.g. "6 monthly for 2 years then annually until 5 years" refer to the time from surgery or from radiotherapy/chemotherapy if no surgery performed. If no treatment had been offered, it refers to the time from diagnosis.

Early post-operative imaging should be attempted in all patients who have had a resection or debulking of an intracranial or spinal tumour. This should generally be an MRI scan but in some cases cranial CT is also appropriate. When imaging

could not be performed prior to discharge, it could be performed on an outpatient basis.

Patients should normally have their case discussed at the Neuro-oncology MDT at the John Radcliffe Hospital following surgery and the follow up imaging schedule to be used should normally be agreed there.

Patients who have evidence of relapse detected on imaging or clinically between interval scans will have further imaging as determined by their subsequent treatment plan.

Glioma – (WHO grade I)

Clinical Management	**Follow up imaging frequency**
Radiological diagnosis or biopsy/subtotal resection then watch and wait policy with radiotherapy reserved for progression.	Scan 6 monthly for 2 years. Then annually until 5 years. Then every 2 years. At any time on symptom progression.
Following complete resection, then watch and wait policy with radiotherapy reserved for progression.	Scan at 6 months, 2 years and 4 years after surgery provided no change is detected. Then on symptom progression only.
Following biopsy/resection, then radiotherapy.	Scan at 3 months after RT. Then 2 years then 5 years provided no change is detected. At any time on symptom progression.

Glioma – (WHO grade II)

Clinical Management	**Follow up imaging frequency**
Radiological diagnosis or biopsy or resection then watch and wait policy with radiotherapy reserved for progression.	6 monthly for 2 years. Then annually. At any time on symptom progression.
Following biopsy/resection + radiotherapy.	At 3 months after RT. Then annually for 5 years. At any time on symptom progression.

Glioma – High grade (WHO grade III and IV) and other high grade tumours (eg chondrosarcoma, aggressive skull base sarcomas,)

Clinical Management	**Follow up imaging frequency**
Following biopsy/resection alone	If too unwell for RT treatment, often no imaging.
Following biopsy/resection + radiotherapy	At 2 months after completing RT. At six months if patient had Temozolomide. Annual scans OR on symptom progression.

High grade Neuroectodermal tumours and germ cell tumours (eg PNET, medulloblastoma, pineoblastoma, ependymoblastoma, germinoma and teratoma).

Clinical Management	**Follow up imaging frequency** **NB Whole CNS imaging required.**
Following biopsy/resection + cranio-spinal radiotherapy	At 2 months after completing RT. Annual scans for up to 5 years OR on symptom progression.

Pituitary Adenoma

Clinical Management	**Follow up imaging**
Conservatively managed non-functioning adenomas	MRI at 6 months. Then annual scans to 6 years. Then bi-annual scans.
Non-functioning adenomas treated by TSA	MRI at 3 months post op. Then annual scan to 6 years. Then bi-annual scans.
Following TSA + radiotherapy	No further imaging unless symptom progression or biochemical evidence of relapse.
Prolactinoma treated with dopamine agonist.	First follow up MRI at 3 months, then yearly MRI for 2 years. Further follow up if coming off dopamine agonist.
Functioning adenomas treated by TSA	Post operative MRI. No further imaging unless biochemical evidence of relapse.

Craniopharyngioma

Clinical Management	**Follow up imaging**

All cases (biopsy or debulking surgery +/- RT)	3 months post completion of therapy (surgery +/- radiotherapy). The annual scans to 5 years. At any time on symptom progression.

Meningioma

Clinical Management	**Follow up imaging frequency**
Radiological diagnosis – watch and wait policy where surgery is indicated in the event of tumour progression.	Annual scans to 5 years. At any time on symptom progression.
Grade 1. Complete excision	At 1 year post op. **If residual disease, see below.** If no evidence disease, further scan at 2 years then 5 years then stop. At any time on symptom progression.
Grade 1 or 2, Subtotal excision or residual disease on 1 year scan, no RT.	At 6 months post op. Then annually until 5 years. At any time on symptom progression.
Any grade 1 or 2 post biopsy/resection + RT	At 6 months post RT, Then 2 and 5 years. At any time on symptom progression.
Any Grade 3 (Op + RT)	At 2 months post RT, then annually to 5 years or on symptom progression

Vestibular schwannoma

Clinical Management	**Follow up imaging**
Radiological diagnosis then medical management alone.	At 6 months then annual scans to 5 years then every 2 years.
Complete excision	At 6 months post op. If no evidence disease, further scan at 2 years then 5 years then stop. If residual disease, see below.
Subtotal excision or residual disease on 6 month scan.	At 6 months post op, Then at 2 years and 2 yearly scans to 10 years.
Following Radiosurgery	MRI at 1, 3, 5 and 10 years post treatment. The 1 year scan should include axial and coronal post contrast T1-W sequences

Haemangioblastoma

Clinical Management	Follow up imaging frequency
Following complete resection	6 months, 2 years then 4 years. Then on symptom progression only.
Incomplete resection or unresected tumours e.g in VHL patient with multiple tumours	6 months then yearly if clinically appropriate. MDT discussion could lead to longer scan interval (e.g. 2 years) if no change detected initially and if clinically appropriate.

Appendix: Scan protocols

General principles:

- MRI is preferable to CT for cranial and spinal imaging due to the higher sensitivity in demonstrating change as well as the lack of ionising radiation.
- CT is a reasonable alternative in emergency cases (particularly for cranial imaging) and where ionising radiation does not present a significant risk.
- Ideally CT scans should comprise a helical acquisition of the whole head pre and post contrast with 5 mm thick axial, coronal and sagittal reconstructions of both acquisitions.
- Contrast material should be administered (unless contraindicated). The exceptions are vestibular schwannomas and pituitary adenomas which do not generally need contrast administration on MRI for the diagnosis to be established.
- Diffusion weighted imaging (if available on the scanner used) should be performed whenever a focal brain lesion / lesions are detected.
- Perfusion imaging and spectroscopy (on brain MRI) should be used when the supervising neuroradiologist thinks that it may add useful information in a particular case.
- Vascular imaging (CTA, CTV, MRA, MRV) may add useful information in selected cases but are not routinely performed.

Specific scan protocols:

Protocol 1: Intracranial tumours (other than those specified in protocols 2 – 5 below)

MRI

All patients:
1. Axial T1 + T2 + DWI
2. Coronal FLAIR
3. Axial , coronal and Sagittal T1 Post Gadolinium or T1 volume (e.g. FMSPGR) with 3 plane reconstructions at 2mm slice thickness if done at 3T. When a patient with a brain mass lesion or lesions is scanned for the first time the T1 post gad images should preferably be aquited as an axial volume sequence without angulation so that the images can be used for image guidance in theatre if a biopsy is indicated.

Selected cases at the discretion of the neuroradiologist / neuroradiologist:
1. MR spectroscopy
2 MR perfusion imaging
3 MRA
4 MRV

CT
1. Helical acquisition of the whole head pre- and post-contrast.
2. Axial, coronal and sagittal reconstructions at 5mm slice thickness of both the pre and post contrast acquisition.
3. Include high resolution thin (1mm or 2mm) bone algorithm reconstructions for tumours involving the cranial vault or skull base.

Protocol 2: Imaging of pituitary tumours

MRI

All patients
1. Axial T2 whole brain
2. Sagittal and coronal high resolution (3mm slice thickness) T1 through pituitary.

Selected cases:
1. Sagittal and coronal high resolution (3mm slice thickness) T1 port Gadolinium through pituitary in selected cases e.g. suspected Cushing's disease.

2. Dynamic contrast enhanced T1 coronal images through pituitary in selected cases where a pituitary microadenoma is strongly suspected but not seen on standard imaging

CT (when MRI is contraindicated):

1. Helical acquisition of whole head with reconstruction in all three planes at 3mm slice thickness using a soft tissue reconstruction algorithm
2. Use IV contrast at discretion of radiologist

<u>Protocol 3:</u> Imaging of tumours that involve the skull base, orbits or paranasal sinuses

MRI

All patients:

1. Axial high res (3mm slice thickness) T2 and T1
2. Coronal high resolution (3mm slice thickness) T1 and STIR
3. Axial and coronal high resolution (3mm slice thickness) T1 post gadolinium. Fat saturation is indicated when the orbits are involved and potentially for other tumours as well (at discretion of radiologist).

Selected cases: (at discretion of radiologist)

1. DWI
2. Axial T2 and/or FLAIR and/or whole brain T1 post gadolinium

CT (when MRI is contraindicated):

1. Helical acquisition of whole head with reconstruction in all three planes at 3mm slice thickness using a soft tissue reconstruction algorithm and at 1mm slice thickness using a bone reconstruction algorithm
2. Use IV contrast at discretion of radiologist – it would usually be indicated
3. CTA / CTV at discretion of radiologist

<u>Protocol 4:</u> Imaging for vestibular schwannoma

MRI

Depending on scanner manufacturer, perform high resolution heavily axial T2 weighted images through IAM's (e.g. Balanced FFE, CISS or FIESTA)

CT (when MRI contraindicated)

Helical acquisition through posterior fossa.

Reconstruction in axial and coronal planes at 3mm slice thickness using a soft tissue reconstruction algorithm and at 1mm slice thickness using a bone reconstruction algorithm.

Protocol 5: Patients with NF2

MRI

Cranium:
Administer gadolinium at start of examination

1. Axial and coronal T1 whole head
2. Axial high resolution (3mm slice thickness) T1 post gadolinium. (fat-sat) to cover from foramen magnum to above orbits.
3. Axial balanced FFE or CISS or FIESTA (depending on scanner manufacturer) through cranial nerves III – 12 and cantered on the IAMs
4. Axial T2 whole head

Spine:

1. Sagittal T1 and T2 whole spene in 2 blocks
2. Coronal T1 and T2 whole spine in 2 blocks
3. Axial T2 and T1 through any area of potential cord or cauda equina compression

Protocol 6: Spinal cord, filum terminale, spinal nerve-root or cauda-equina tumour

MRI

1. Sagittal T1 and T2
2. Axial T1 and T2
3. Post gadolinium sagittal and axial T1
4. Coronal T1 and T2 images at discretion of radiologist for tumours extending significantly through neural exit foramina.

CT (when MRI contraindicated)

1. Helical acquisition post IV contrast through relevant area of spine with reconstruction in axial, sagittal and coronal planes at 3mm slice thickness using a soft tissue reconstruction algorithm and at 2mm slice thickness using a bone reconstruction algorithm.
2. Consider CT Myelogram

Protocol 7: Suspected malignant spinal cord or cauda equina compression

MRI

1. Sagittal T1, T2 and STIR whole spine
2. Axial T1 and T2 through any area suspicious for malignancy
3. Post gadolinium sagittal and axial T1 at discretion of radiologist

CT (when MRI contraindicated)

1. Helical acquisition through relevant area of spine with reconstruction in axial, sagittal and coronal planes at 3mm slice thickness using a soft tissue reconstruction algorithm and at 2mm slice thickness using a bone reconstruction algorithm.
2. Consider CT Myelogram