Basics of MRI: How I do it?

Neuroradiology

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Fondation Rothschild techs & radiologists
IRM Paris 13 technologists
Basics of MRI: How I do it?

NeuroRx Quick wins

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Learning objective
Participants will be able to...

• Apply patients and slice positioning

• Implement some tips to improve productivity and exam reliability
1.5T workload
(outpatient imaging center)

Specialized Neuro

- Neuro-Onco: 5%
- Neuro Spec: 15%
- Neuro Easy: 20%
- Head & Neck: 60%

General Neuro Head & Neck

- Neuro-Onco: 10%
- Neuro Spec: 40%
- Neuro Easy: 10%
- Head & Neck: 40%

Mean Nr. of MRI exams / day (/ hour)
- 40 (3,0)
- 44 (3,4)

Mean exam time
- 16 min
- 14 min

Mean interscan time
- 4 min
- 3 min
Aims:

• More patients per day, per year

• Shorten delays for patients (at a constant number of MR devices for a given population)

• Profitability
Positioning patients

- Head coil / Head & neck (Neurovascular) coil
- Consider soft paddings to reduce head motion

- Group head & spine / cord exams (table coil)
  - to avoid coil changes

- Annoyance:
  - Severe kyphosis
  - Camptocormia
  - Patient’s head may not fit the coil
Impossible to put the head coil due to scoliosis => 2 Flex coils around the head
Image quality could still be decent without a head coil
Positioning slices: Sagittal plane

AP FOV
220 – 240 mm
Avoid cutting the nose
More lateral coverage for Sag 3D acquisitions. Cover the entire ears as parallel imaging may induce foldover artifact inside the brain.
Positioning slices: Axial plane
Positioning slices : Axial plane
Have MR protocols ready
One doesn’t fit all patients, indications

Sag T1
Ax FLAIR 5/1
Coro T2
Ax Diffusion
3D TOF
3D T1 Gre post-Gd
Like a construction game. Chose pieces
• 2 strategies:
  few “long” sequences VS many “short” sequences
Have MR protocols ready
Structured list according to clinical situations

Brain
- Neurology
  - Headaches
  - White matter
  - Memory loss
  - Movement disorders
  ...
- Stroke
- Tumors
- ENT
  - IAC (Hearing loss, dizziness)
  - Pulsatile tinnitus
  ...
- Eye & Orbit
Have MR protocols ready
Several flavors for close clinical situations

<table>
<thead>
<tr>
<th>Protocol name</th>
<th>Specificity</th>
</tr>
</thead>
<tbody>
<tr>
<td>11mn Acute stroke (&lt;6hr)</td>
<td>Short, SAA</td>
</tr>
<tr>
<td>4mn Acute stroke agitated pt.</td>
<td>Single shot sequences, very short</td>
</tr>
<tr>
<td>14mn Hematoma</td>
<td>4D angio</td>
</tr>
<tr>
<td>22mn Transient ischemic attack</td>
<td>HR Diffusion, ASL perfusion, SAA</td>
</tr>
<tr>
<td>16mn Acute stroke (&gt;6hr)</td>
<td>Better quality, SAA</td>
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</table>
Contrast injection

• Injection is not always useful (dementia, epilepsy)

• If you need injection, do you really need pre-contrast acquisition?

• If automatic injector is needed (perfusion, CEMRA, dynamic MRA), make sure everything is ready before the patient enters the exam room
# Radiologist: Checklist & report template

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<td>Posterior fossa</td>
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</tr>
<tr>
<td>Cranio-vertebral junction</td>
<td>✓</td>
</tr>
<tr>
<td>Cerebellum &amp; brainstem</td>
<td>✓</td>
</tr>
<tr>
<td>Cisterns, 4th ventricle, aqueduct</td>
<td>✓</td>
</tr>
<tr>
<td>Supra-tentorial</td>
<td></td>
</tr>
<tr>
<td>Midline</td>
<td>✓</td>
</tr>
<tr>
<td>Parenchyma: morphology, signal, enhancement</td>
<td>✓</td>
</tr>
<tr>
<td>Ventricles &amp; meninges</td>
<td>✓</td>
</tr>
<tr>
<td>Vessels</td>
<td>✓</td>
</tr>
<tr>
<td>Misc (paranasal sinuses, orbits, pituitary...)</td>
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## Tech: Quality check & rule out disease that would need further sequences

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Tension headaches
Migraine
...

Most causes have normal imaging

Rare but life-threatening diseases may be found at MRI

Venous thrombosis
Aneurysm
Dissection
Tumor, abscess
Hematoma
Learning objectives
Participants will be able to...

• Plan their MRI reading

• Recognize a limited number of relevant diseases
  – frequent
  – Rare but important

• Construct a standardized and meaningful protocol

• Discuss current controversies

Quality check for techs
Learning objectives
Participants will be able to...

• Plan their MRI reading

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• Construct a standardized and meaningful protocol

• Discuss current controversies
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• **Construct a standardized and meaningful protocol**

• Discuss current controversies
Learning objectives
Participants will be able to...

• Plan their MRI reading

• Recognize a limited number of relevant diseases
  – frequent
  – Rare but important

• Construct a standardized and meaningful protocol

• Discuss current controversies
Did you look at...?

- CV junction
- Space-occupying lesion
- Meninges signal (FLAIR, SWI)
- Veins
- Arteries
- Paranasal sinuses
- Pituitary gland
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  - Paranasal
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Thrombus appears as a filling defect on CE-mra and is strongly hypointense on T2*
Small & cortical DVT may be better seen on SWI or raw images from CEmra
Flow related techniques such as PC may falsely lead to a diagnosis of venous thrombosis in case of slow flow such as in the left lateral sinus.
Relevant diseases
Dissection

3D TSE T1 FS BB

CE-MRA

3D TSE T2 FS BB
Up: high grade glioma
Down, left: colloid cyst in the 3rd ventricle associated with hydrocephalus
Down, right: cavernoma
Tension headaches
Migraine
...

Most causes have normal imaging

Rare but life-threatening diseases may be found at MRI

Venous thrombosis
Aneurysm
Dissection
Tumor, abscess

Imaging «game-changers»

IC Hypotension
IIH
Paranasal sinusitis
Pituitary apoplexy
Diffuse and regular (without nodules) dural thickening
Sphenoidal sinusitis
Apoplexy
Protocols

- Mass & hemorrhage
- Meninges & Ventricles
- Veins
  - Lumen imaging (CEMRA > Flow-related MRA)
  - Thrombus (SWI)
- Arteries: thunderclap, SAH, Horner

Progressive headaches (not thunderclap)

- Sag T1 (fast)
- 3D CE-MRA (large FoV, arteries & veins)
- SWI (or T2*)
- 3D FLAIR (Gd, fast)
- 3D TSE T1 (Gd)
Protocols

- Mass & hemorrhage
- Meninges & Ventricles
- Veins
  - Lumen imaging (CEMRA > Flow-related MRA)
  - Thrombus (SWI)
- Arteries: thunderclap, SAH, Horner

Thunderclap headaches

Sag T1 (fast)
3D TOF
3D CE-MRA (veins)
SWI (or T2*)
3D FLAIR (Gd, fast)
3D TSE T1 (Gd)
Protocols

- Mass & hemorrhage
- Meninges & Ventricles
- Veins
  - Lumen imaging (CEMRA > Flow-related MRA)
  - Thrombus (SWI)
- Arteries: thunderclap, SAH, Horner

Headaches + Horner

3D or Ax Black Blood T1 (TSE, head & neck, fat suppression)
3D TOF
3D CE-MRA (supraaortic art)
SWI (or T2*)
3D FLAIR (Gd, fast)
3D TSE T1 (Gd)
Controversy
Aneurysm screening?

Headaches

3D TOF

Aneurysm
Aneurysm is the cause of headaches + Risk of SAH and death Endovascular Or surgery
Controversy
Aneurysm screening?

Chronic, non-thunderclap Headaches

3%

3D TOF

Aneurysm

Aneurysm is not the cause of headaches + Risk of SAH usually low

Don’t know if treatment will do more good than harm
Basics of MRI: How I do it?
Dizziness & SN Hearing loss

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Most causes have normal imaging

Rare but potentially progressive diseases may be found at MRI

Age-related
Benign paroxysmal positional vertigo
Meniere's disease

Vest. Schwannoma
Inflammatory
Ischemic stroke
Did you look at...?

- CV junction
- Space-occupying lesion
- Posterior fossa FLAIR / DWI
- IAC mass
- IAC / labyrinth morphology
Did you look at...?

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Relevant diseases

Vestibular Schwannoma

3D T2 TSE (DRIVE)  3D T1 Thrive + Gd  3D FLAIR + Gd
Upper images: 2 broad-based dural fully enhancing lesions: meningiomas

Lower images: non-enhancing lesion in T2 high-SI but not exactly the same signal as CSF on FLAIR and cisternographic T2 sequence: epidermoid cyst
Multiple sclerosis with pontine and cerebellar peduncles active lesions.
Note that some of the supra-tentorial lesions are centered by venules on SWI imaging.
Postero-lateral medulla infarction with cervical vertebral artery dissection
**Protocol**

- Quick analysis of parenchyma
  - Vascular
  - Inflammation

- IAC & cisterns
  - Vestibular schwannoma
  - Other tumors
  - Cysts

- Sag T1 (fast)
- Coro T2 (very fast)

- **IAC 3D T2** cisternographic (DRIVE, E-FFE, FIESTA, CUBE, CISS, SPACE)

- **IAC 3D T1** fat suppression

- Ax DWI

- 3D/Ax FLAIR (Gd, fast)
- 3D/Ax TSE T1 (Gd, fast)
Positioning in the sagittal plane: 2 anatomical landmarks

- Median sagittal slice: pons-medulla junction
- Slightly more lateral slice: IAC is cut perpendicularly and appears as a gray disc within the black petrous bone
Adjust the lateral obliquity in coronal plane
Small intralabyrinthine schwannoma, very difficult to depict on cisternographic images alone, easier to see on T1 post-gad sequence
Controversy

To Gad or Not To Gad?
Basics of MRI: How I do it?

Memory loss

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Did you look at...?

- Big things
  - Tumors
  - Subdural hematoma
  - Hydrocephalus

- White matter
- Microhemorrhages
- Atrophy
  - Hippocampus
  - Paramedian cortex
Did you look at...?

• Big things
  – Tumors
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Did you look at...?

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• White matter
• Microhemorrhages
• Atrophy
  – Hippocampus
  – Paramedian sagittal slice
Did you look at...?

- Big things
  - Tumors
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  - Hydrocephalus

- White matter
- Microhemorrhages
- Atrophy
  - Hippocampus
  - Paramedian sagittal slice
Relevant diseases

Small vessel disease
Atrophy with ventricular enlargement but no hippocampal involvement if small vessel disease is isolated
Up : old lacunar infarction
Down : microbleeds on T2* sequence. If several peripherical microbleeds present, amyloid angiopthy may be discussed
Relevant diseases
ddx: Small vessel disease

- Any mass effect
- No spared WM
- Asymmetric involvement,
  Corpus callosum or optic radiation

→ Do an additional post-gad study

Lymphoma
Hippocampus atrophy
Precuneus atrophy visible on sagittal plane
Frontal meninioma
Subdural hematoma
• Rule out tumor & extra-axial hematoma
  – Quick morphologic check-up (without injection)
• Careful analysis of atrophy
• White matter
• Microbleeds
• Diffusion abnormalities

Usually no injection

3D Gre T1 1mm iso
(MPR: Ax, Sag, coro oblique)

Coro IR or T2 HR
(coro oblique)

3D or Ax FLAIR (fast)

T2* (+/- SWI)

DWI
Coronal oblique slice positioning

2 – 2.5 mm
No gap
Basics of MRI: How I do it?

Acute neurological deficit

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Acute neurological deficit: how urgent?

When last seen normal?
Persistant or transient deficit?

< 6h

Don't lose a minute!
MRI
CT / CTA

< 24h

Within 6h
MRI
CT / CTA

> 24h
TIA

Within 24h
MRI
CT / CTA
Controversy
MRI or CT?

MRI
- Core assessment
- Differential diagnoses
- One-stop shop

CT
- Very fast
- Available anywhere anytime
- Vessel assessment
Relevant diseases
Hematoma
Relevant diseases
Old infarction
Relevant diseases
Acute ischemic stroke
Up: Acute stroke < 6hrs: usually no FLAIR abnormality except slow vessels in high-SI
Down: Stroke in diffusion high SI with low ADC and high FLAIR SI – usually more than 6 hrs and less than 1 week
Relevant diseases

Acute ischemic stroke
Better vessel assessment including thrombus site, length with CE-MRA and SWI
Cemra: simultaneous assessment of supraaortic arteries: useful if endovascular procedure is done after the MRI
# Protocol

- **Core**
  - Ax DWI
  - 3D TOF (fast)
  - Ax FLAIR (Gd, fast)
  - 3D CE-MRA (supra-aortic arteries and CoW)
  - SWI (or T2*)

- **Blood?**
  - (In that order)

- **Other ddx**

- **Vessels including clot**

**Prep injection before patient enters the room**