I am a “new age” radiologist

I run consulting rooms and public clinics for neurovascular patients and admit and treat patients in public and private

I am partner in a radiology practice where I report complex neurovascular imaging and perform spinal injections for pain

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CEREBROVASCULAR DISEASES

Learning objectives

- Pathology/pathophysiology, epidemiology
  1. Know the aetiology/pathogenesis of common neurovascular diseases
  2. Know the incidence/prevalence of common neurovascular diseases

- Investigation
  1. Know the common clinical presentations of neurovascular diseases
  2. Know the appropriate tests for suspected neurovascular diseases
  3. Know the ancillary investigations required in management of neurovascular diseases

- Evidence-based diagnosis and management
  1. Know the main publications supporting modern treatment of neurovascular diseases
  2. Know the main treatment methods for neurovascular diseases

Questions...

TRUE OR FALSE:

In the setting of carotid atheroma, ischaemic stroke is most commonly due to reduced cerebral perfusion.

Questions...

WHICH OF THE FOLLOWING IS NOT AN APPROPRIATE URGENT INVESTIGATION FOR ACUTE ISCHAEMIC STROKE:

a. Duplex ultrasound of the carotid arteries
b. CT brain
c. CT angiogram of the arch/COW

Questions...

STANDARD OF CARE FOR ACUTE ISCHAEMIC STROKE DUE TO LARGE VESSEL OCCLUSION IS:

a. Heparin infusion + stroke unit care
b. rt-PA infusion + stroke unit care
c. Endovascular clot retrieval +/- rt-PA infusion
COMMON SYMPTOMS/SIGNS OF POSTERIOR CIRCULATION ISCHAEMIA INCLUDE:

a. “Crossed paresis”, dysconjugate gaze, ataxia
b. Expressive dysphasia, apraxia, gaze deviation
c. Decreased LOC, pseudobulbar palsy, headache

INDEPENDENT PATIENT OUTCOMES IN GOOD-GRAGE ANEURYSMAL SUBARACHNOID HAEMORRHAGE ARE SIGNIFICANTLY BETTER WITH:

a. Conservative (medical) management
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c. Endovascular repair (coiling) of aneurysm

WITHOUT TREATMENT, REBLEEDING FROM RUPTURED INTRACRANIAL ANEURYSM OCCURS IN:

a. 1% at 30 days
b. 90% at 30 days
c. 30% at 30 days

SMALL (<7mm) UNRUPUPTURED ANEURYSMS IN THE ANTERIOR CIRCULATION:

a. Usually double in size every 5 years on average
b. Have a very high (>20% per year) bleeding risk
c. May be managed conservatively in most cases

PULSATILE TINNITUS

a. Is a common symptom of brain AVM
b. Is a common symptom of Menière’s Disease
c. Is a common symptom of dural arteriovenous fistula

Overview

*Common neurovascular diseases*
  - Stroke
    - Ischaemic (85%)
    - Haemorrhagic (15%)
  - Other
    - Shunts
      - Arteriovenous malformation (AVM)
      - Dural arteriovenous fistula (DAVF)
    - Tumours
Overview
- Management of neurovascular disease
  - Medical
  - Open surgical
  - Endovascular (Interventional Neuroangiology)

Stroke - ischaemic
- 85% of all stroke
- 2nd leading cause of death and disability in Australia
- Leading cause of permanent dependency in Australia
- Causes
  - Cardioembolic 60%
  - Atheroembolic 20%
    - Carotid/vertebral 15%
    - Aortic arch 5%
  - Dissection/hypoperfusion ~1%
  - "Cryptogenic" ~20%

Stroke - ischaemic
- Cardioembolic stroke – causes
  - Atrial fibrillation or "atrial cardiopathy"
  - Patent foramen ovale
  - Myocardial infarction (hypomobile segment(s))
  - Bacterial endocarditis

- Atheroembolic
  - Carotid atheroma
  - Arch/vertebral origin atheroma
  - Intracranial atheroma

Stroke - ischaemic
- Clinical presentation
  - TIA – warning sign!
    - Focal deficit (including amaurosis) resolving in <24h
    - Must be treated as a medical emergency like "brain angina"
    - 15-25% will progress to major stroke within 2-4 weeks
    - Must admit and investigate
    - Usually a sign of unstable/ulcerated/embolic/embolic carotid plaque
  - TIA workup:
    - MRI and MRA brain – diffusion to look for acute ischaemia
    - CT angiogram aortic arch to COW – evaluate extracranial circulation
    - EEG/rhythm monitoring

Stroke - ischaemic Sx and signs
- Anterior circulation:
  - Contralateral hemiparesis/monoparesis/facial droop
  - Slurring of speech (non-dominant)
  - Dysphasia (expressive/receptive/mixed – dominant hemisphere)
  - Eye deviation (toward the affected hemisphere)
  - Contralateral sensory loss, sensory inattention/neglect
  - Hemianopia
  - Somnolence, vomiting, seizure (in large vessel occlusions)
Stroke – ischaemic Sx and signs
- Posterior circulation
  - Decreased level of consciousness
  - “Crossed” paresis – ipsilateral face, contralateral body
  - Quadriplegic or “locked in syndrome”
  - Impaired gag, swallow
  - Dysconjugate eye movements, diplopia
  - Arrhythmia, respiratory impairment
  - Seizure
  - Ataxia
  - Vomiting

Stroke – Investigations
- Urgent – immediate diagnosis is crucial
- Ischaemic tissue loses 2M neurons/minute
- Purpose of investigations:
  1. Establish diagnosis of ischaemic stroke
  2. Identify/exclude large vessel occlusion (LVO)
  3. Identify salvageable brain tissue
  4. Identify cause of stroke
    - Carotid disease
    - Arch atheroma
    - Other

Stroke – Investigations
- First line in suspected AIS is non-contrast CT head
  - Excludes haemorrhage
  - May identify LVO
  - Shows obviously infarcted tissue
- Same visit: CT angiogram arch-to-COW
  - Confirm/exclude LVO
  - Demonstrate source of embolus
  - Assist interventionist and neurologist in planning management

Stroke – Investigations
- In large stroke centres, CT-perfusion can be obtained at same time as CT angiogram
  - May delineate infarcted tissue
  - May demonstrate “penumbra” of salvageable but ischaemic brain

Stroke – Treatment
- Until mid-1990s, treatment of AIS focused on
  - preventing further stroke
  - avoiding complications (DVT, pneumonia)
  - promoting rehabilitation
- Late 1990s to 2000s
  - PROACT-I and II trials
  - rt-PA infusion became standard of care
    - Within 3-4 hours of stroke onset
    - Improved independent outcomes to 25-30%
    - Cerebral haemorrhage risk in 14-17%

Stroke – Treatment
- Late 2000s
  - Interventional techniques – experimental
  - Clot retrieval devices (MERCI, Solitaire)
  - IMS-III trial – endovascular vs rt-PA
    - Stopped in 2010 for futility
    - Flawed trial:
      - 4/434 patients had stent-retriever technology used
      - No requirement to prove vessel occlusion on imaging
      - Delayed management in many patients in trial
    - New trials devised to assess modern imaging and revascularisation techniques vs rtPA alone.
**Stroke – Treatment**

- **Trials and meta-analyses showed:**
  - Patients with large vessel occlusion (LVO) do significantly better with endovascular clot retrieval (ECR) as measured with 90 day mRS
  - ECR is cost-effective
  - Older patients (>80) do as well or better
  - ECR is effective to at least 6 hours (recent trials – DAWN – show benefit to 24h)
  - NNT for ECR is 2.5-3 (cf PCI for heart 20-35)

- **After CT/CTA/CTP…**
  - Patient taken as quickly as possible to DSA
    - GA or conscious sedation
    - Femoral artery access
    - Affected territory (RICA, LICA, VA) selected
    - Angiograms performed – demonstrate/locate occlusion
    - Intracranial access with microcatheter/wire
    - Deploy stent-retriever +/- aspiration catheter
    - Retrieve embolus

- **Case example**
  - 1430 – telephone call from stroke registrar at Wollongong Hospital to duty INR at POW
  - 51F, D1 post TKR
  - LS&W@1300h
dense left face/arm hemi + eye deviation, neglect and GCS 11.
  - NIHSS 19.
  - CTA – R M1 occlusion.
  - Weather damage to WH helipad; heavy traffic on highway and in South Sydney; thunderstorm moving through Sydney

  - 1520: patient transported by road ambulance; liaison between road and chopper to handover at nearest open space.
  - Patient handed over to chopper 1555h, 50km south of Sydney
  - DSA lab given 20-minute warning – prep commences
  - Patient arrives at POWH helipad 1615h
Case example

- Equipment prep completed 1620
- Patient enters room 1625; on DSA table 1627
- 9F CFA access and invasive pressure monitoring established 1630
- Rapid sequence GA complete 1635
- Embolectomy complete 1655
  - Solumbra pass 1 unsuccessful
  - Solumbra pass 2 successful

Stroke – Treatment

- Procedure typically takes 30-40 minutes from arrival in DSA to groin closure
- POW/Liverpool ECR service – 20-30/month
- Research opportunities available!

Stroke – Haemorrhagic

- Common
  - Hypertensive lobar/ganglionic bleed (50-60%)
  - Aneurysmal subarachnoid haemorrhage (25-30%)
- Rare
  - Arteriovenous malformation (AVM)
  - Cavernoma
  - Dural arteriovenous fistula (DAVF)

Aneurysms

- Aneurysmal subarachnoid haemorrhage (aSAH)
  - 8/100,000 incidence in Australia
  - Peak in 5th-7th decades
  - F:M = 2:1
  - Principal risk: smoking; 5% familial
  - 20% of aneurysm patients have >1 aneurysm
  - 10-15% mortality at ictus
  - Untreated, 30% will rebleed by 30 days & 60% will be dead at 6 months
  - Each rebleed carries 50% mortality
**Multiple aneurysms**
- Occur in 20% of patients
- Which has ruptured?
  - CT blood pattern
  - Localising clinical signs
  - Aneurysm size and shape
- When in doubt, treat the largest first
- If time, treat as many as can be safely treated at one sitting

**Aneurysms**

**Aneurysmal subarachnoid haemorrhage (aSAH)**
- Clinical symptoms
  - LOC
  - “Thunderclap” headache
  - Meningismus – headache, N/V, photophobia, neck stiffness
  - Focal deficit (esp IIIIn palsy)
- Imaging
  - Non-contrast CT brain
    - >98% sensitive and specific for SAH in 1st 24 hours
    - Falls to 57% by 10 days
    - Excludes focal haematoma with mass effect
  - Obstructive hydrocephalus
  - CT angiography – to locate aneurysm and characterise for treatment planning.

**Aneurysms - unruptured**
- Usually incidentally discovered
- Risk of treatment vs risk of rupture
- Generally, anterior circulation aneurysms <7mm have a low rupture risk and can be managed conservatively
- Aneurysms >7mm and most posterior circulation aneurysms should be considered for treatment
- Higher risk in patients with previous SAH or ≥2 first degree relatives with aSAH.

**Aneurysms**

**Treatment**
- Microneurosurgical clipping
  - Craniotomy and open exposure of aneurysm
  - Dissection around aneurysm neck
  - Clip placed across neck
- Endovascular occlusion
  - Percutaneous arterial access (usually common femoral)
  - Microcatheter advanced into aneurysm
  - Aneurysm packed with platinum coils

**International subarachnoid aneurysm trial (ISAT) of neurosurgical clipping versus endovascular coiling in 2143 patients with ruptured intracranial aneurysms: a randomised comparison of effects on survival, dependency, seizures, rebleeding, subgroups, and aneurysm occlusion**

Andres P. Churly, MD, 1,2 Rafael Ayala, MD, 1,2 Yi-Min Liu,3,4 Wei-Ping Yan,3,4 Italo Della Corte, MD, 3,4 Mary Moodie,5,6 Susan Vennk,5,6 Peter Sandercock,5,6 on behalf of the International Subarachnoid Aneurysm Trial (ISAT) Collaborative Group

7.6% absolute benefit for coiling over clipping at 12 months, maintained in the group of coiled patients in the 15 years since publication
Aneurysms

- Endovascular therapy and aneurysm morphology
  - “simple” coiling where the aneurysm neck is narrow compared with the sac
  - Balloon or stent-assisted coiling where aneurysm neck is broad
  - In some cases, “flow-diverting” stents can be used without coils

The Procedure

- Microcatheeterise aneurysm
- “Frame” aneurysm with first coil
- “Fill” aneurysm with smaller and smaller coils
- “Finish” aneurysm with very soft coils
- Post-coiling angiograms

The Procedure

- Stent-supported coiling
  - Deliver stent across neck of aneurysm
  - Catheterise aneurysm through stent struts
  - Coil aneurysm
35 m – worsening quadriplegia

38 f – bilateral III palsy

63 f – left III, IV, VI and V2 palsy
Arteriovenous Malformation (AVM)

- Dysplastic arrangement of pial arteries and veins with direct A-V connections through a "nidus" of abnormal, thin-walled vessels and no intermediary capillary bed
- Prevalence of 2-3/100,000
- M=F
- Usually present in 4th-6th decades
  - Haemorrhage
  - Seizure
  - Progressive deficit

Diagnosis
- MRI – evidence of prior bleed; vessels on MRA; shunting on TR-MRA
- CT – acute haemorrhage; vessels on CE-CT or CTA; calcification in nidus
- DSA – nidus, AV-shunting

Grading: based on size of nidus, eloquence of adjacent cortex and venous drainage (deep or superficial) – Spetzler-Martin system
- Nidal size:
  - <3cm – 1
  - 3-6cm – 2
  - >6cm – 3
- Elocuence of cortex
  - Non-eloquent - 0
  - Eloquent (ie motor, primary sensory, speech) – 1
- Venous drainage
  - Superficial – 0
  - Deep – 1
- Add scores to get Spetzler grade
Arteriovenous Malformation (AVM)

- **Treatment**
  - Surgery
  - Radiosurgery
  - Embolisation
  - Combinations – E + S, E + R, E + R + S etc

- **Grade vs preferred treatment modality**
  - Grades 1-2: generally surgery preferred
  - Grades 3-5: radiosurgery or combination therapy

Dural Arteriovenous Fistula (DAVF)

- **Rare** – incidence 1-2:100,000 per year

- **Presentation**
  - Pulsatile tinnitus
  - Pulse-synchronous bruit
  - Proptosis/chemosis (cavernous sinus DAVF)
  - Headache
  - Dementia
  - Progressive deficit
  - Haemorrhage (parenchymal, SAH or SDH)

Dural Arteriovenous Fistula (DAVF)

- **Diagnosis**
  - Often difficult due to wide range of clinical features
  - **CT/MR**
    - Distended leptomeningeal veins
    - Abnormal enhancement of sinuses
    - Distended superior ophthalmic vein (cavernous lesions)
  - **Shunting on TR-MRA**
  - **DSA**
    - AV-shunt from ECA branches to dural sinuses
    - Occipital/asc. Pharyngeal/MMA aa to TS/SS/SSS
    - IMAX to CS
    - Retrograde leptomeningeal venous drainage

Dural Arteriovenous Fistula (DAVF)

- **Grading** – reflects risk of haemorrhage and depends on
  - Antegrade or retrograde flow in dural sinuses
  - Presence or absence of reflux into leptomeningeal veins (RLVD)
  - Presence or absence of distension of leptomeningeal veins

- **The most dangerous lesions** have retrograde sinus flow, RLVD and distended leptomeningeal veins, with up to 40% annual haemorrhage risk

Dural Arteriovenous Fistula (DAVF)

- **Treatment**
  - Surgery
    - Cranotomy and disconnection of dural arterial supply and connections between sinus and leptomeningeal veins
  - Radiosurgery – rarely used
  - Embolisation
    - Mainstay of treatment
    - Until 2003, particles, coils, glue injected into feeding arteries with limited success; coil sacrifice of draining sinus effective when possible
    - After 2003, transarterial injection of DMSO-based liquids has become the mainstay of treatment
68 m – obtunded and worsening dementia

52F; subarachnoid haemorrhage
No transvenous access; multiple shunt points

67F; proptosis, chemosis, headache
No transvenous (IPS) access; multiple shunts from both ICAs and ECAs
Questions...

TRUE OR FALSE:

Ischaemic stroke is most commonly due to reduced cerebral perfusion due to carotid stenosis

FALSE

Questions...

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