

Sturge-Weber syndrome (Encephalotrigeminal Angiomatosis)

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STURGE-WEBER SYNDROME - congenital SPORADIC phacomatosis with **capillary venous ANGIOMAS** in **leptomeninges, skin of face, eye**.

PATHOPHYSIOLOGY

- **residual embryonal blood vessels** with secondary effects on surrounding brain tissue.
- normally, in 6th week vascular plexus develops around cephalic portion of neural tube, under ectoderm destined to become facial skin; vascular plexus regresses around 9th week of gestation.
- failure of normal regression → angiomas.
- neurologic dysfunction results from secondary effects:
 - a) "vascular steal" around angioma → hypoxia, ischemia
 - b) venous occlusion, thrombosis, infarction.
- secondary effects are **aggravated by recurrent seizures** (even when short) → **progressive dystrophic calcification***, gliosis, atrophy → neurologic deterioration, seizures↑.

Although leptomeningeal angioma is static anatomic lesion, syndrome has progressive nature!

*N.B. calcifications are located primarily in cerebral substance rather than in vessel walls

ETIOLOGY

- no recognizable genetic contribution; **somatic mutations** affecting:
 - a) structure blood vessels (vessel circumference decreased, while vessel density increased)
 - b) innervation of blood vessels (malformed vessels innervated only by noradrenergic sympathetic fibers)
 - c) expression of extracellular matrix (fibronectin↓) and vasoactive molecules (endothelin-1 expression↑ in malformed vessels).

EPIDEMIOLOGY

INCIDENCE - 1 per 50,000

PATHOLOGY, CLINICAL FEATURES

All lesions (if unilateral) tend to be ipsilateral!

No increased propensity for cancer!!!

1. Leptomeningeal angiomas

- **unilateral** (85%) > bilateral (15%).
- most common in *parietal* and *occipital* regions.
- ipsilateral features - cerebral hemiatrophy, hemihypertrophy of skull and sinuses, enlarged choroid plexus, abnormal myelination.
- cortical veins are either absent or replaced by few enlarged cortical veins.
- neurologic manifestations:
 - 1) **seizures** (72-93%) - typically focal; may be intractable; 75% before age of 1 year, 95% begin **before 5 years**.
 - 2) **focal deficits** (esp. **hemiparesis** [25-56%], **homonymous hemianopsia** [44%]) - may be transient ("strokelike episodes"), but otherwise slowly progressive.
 - 3) vascular **headaches** ("symptomatic migraine") (44-77%)
 - 4) **developmental disorders** (50-75%) (developmental delay, learning disorders, mental retardation) - more common when angiomas are bilateral.

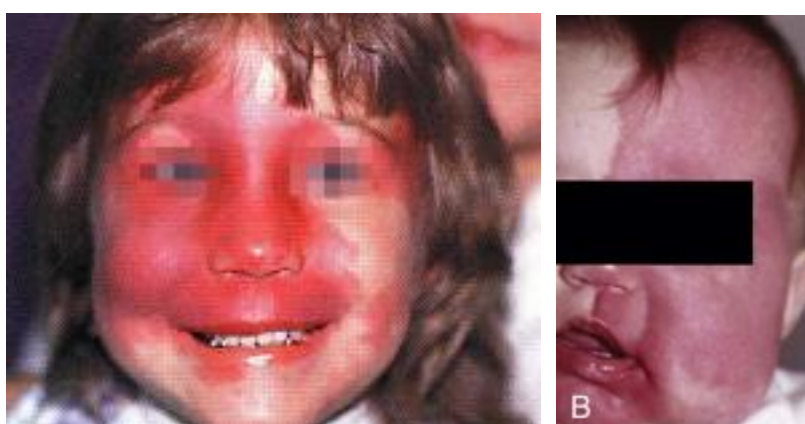
N.B. major intracranial hemorrhage is rare!

2. Cutaneous angioma ("port-wine stain" s. nevus flammeus) (87%) in skin of face.

N.B. most patients with facial **port-wine stains** do not have SWS!

N.B. presence of port-wine stain implies neither presence nor severity of intracranial leptomeningeal angiomatosis (only 8% of facial port-wine stains have this association)

- typically in V₁ and V₂ distributions of CN5.
CNS is not affected if **port-wine stain** does not involve V₁ area!
- **unilateral** (49-86%; ipsilateral to CNS lesion) > bilateral (14-51%).
- presents **at birth** – suspicion of diagnosis in neonate!
- can be progressive (light pink macule → dark red or purple nodular lesion).



Source of picture: H. Richard Winn "Youmans Neurological Surgery", 6th ed. (2011); Saunders; ISBN-13: 978-1416053163 >>

3. Glaucoma (30-71%) → **buphthalmos** (hydrophthalmia) → blindness.

N.B. glaucoma typically occurs only when **port-wine stain** involves eyelids!; if **port-wine stain** is unilateral, glaucoma is ipsilateral!

- causes: mechanical angle obstruction, episcleral venous pressure↑, secretion↑ of aqueous fluid (by choroidal hemangioma or ciliary body).

- may be present at birth but can develop at **any age**.

4. **Eye hemangiomas** – choroidal (40%), conjunctival, episcleral.

ROACH SCALE CLASSIFICATION

Type I - both *facial* and *leptomeningeal* angiomas; may have glaucoma.
Type II - *facial* angioma alone (no CNS involvement); may have glaucoma.
Type III - isolated *leptomeningeal* angiomas; usually no glaucoma.

DIAGNOSIS

Structural versus functional mismatch (functional neuroimaging demonstrates greater area of involvement than structural neuroimaging) - especially important when considering epilepsy surgery!

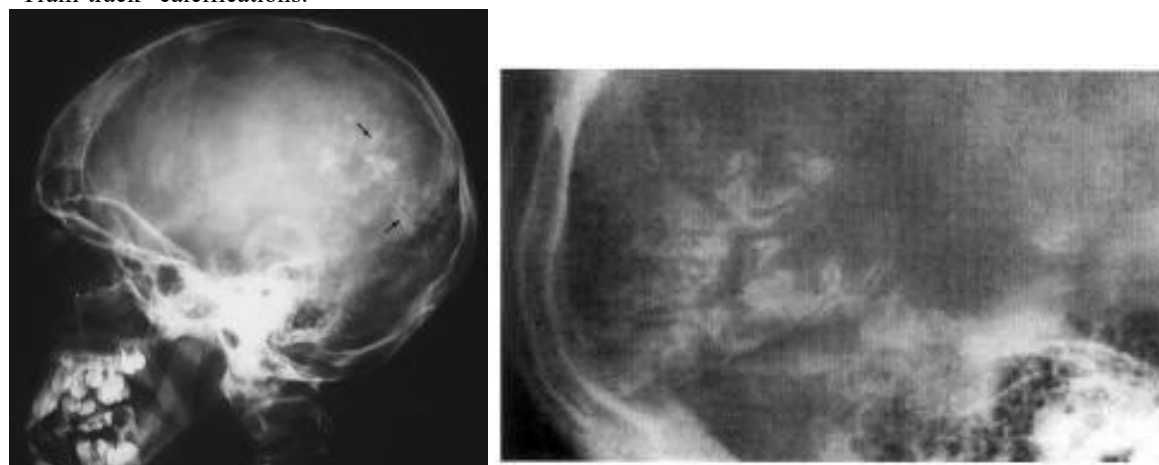
Skull X-ray – pathognomonic **subcortical “tram-track” calcifications in gyriform pattern** (late finding – usually in **patients > 2 yrs**) - paired parallel lines that follow cerebral convolutions.

N.B. **calcification in ipsilateral* outer cortex** rather than of blood vessels or white matter!

*ipsilateral to port wine stain

- underlying ipsilateral cerebral atrophy → ipsilateral skull-table and orbital thickening, elevation of sphenoid wing and petrous ridge, enlarged ipsilateral paranasal sinuses and mastoid air cells.

“Tram-track” calcifications:



Smaller hemicranium on affected side:



Angiography – does not show angioma! (or early capillary blush)

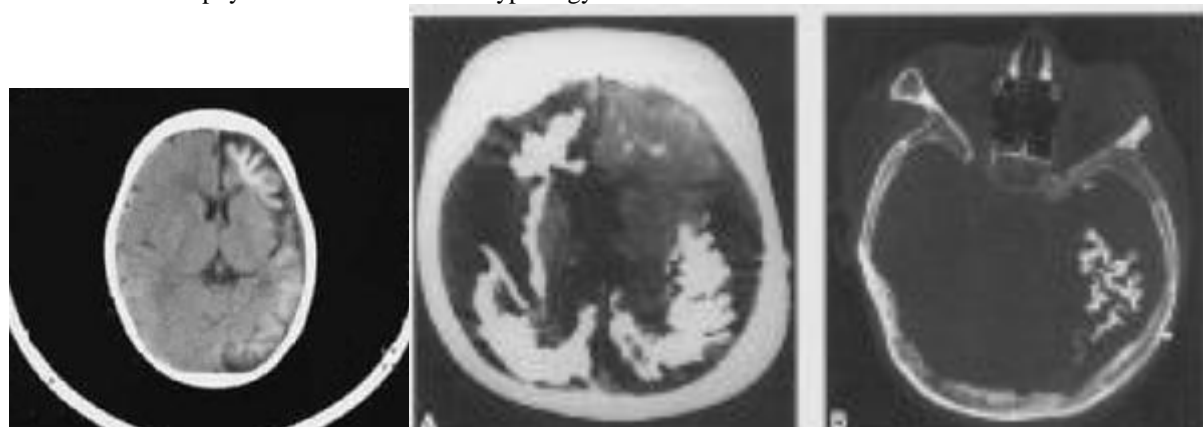
- lack of superficial cortical veins → nonfilling of dural sinuses (with absence of cortical veins, venous drainage occurs via enlarged tortuous transcortical veins into deep venous system).

CT:

- “tram-track” calcifications under angioma (in **infants** and even **neonates**)
- adjacent cortical atrophy.
 Shrunken cerebral lobe with calcified cortex
- enlarged ipsilateral choroid plexus & enlarged draining transcortical draining veins.
- BBB breakdown (during seizures).



CT - left hemiatrophy of cerebral cortex and typical gyral calcification:

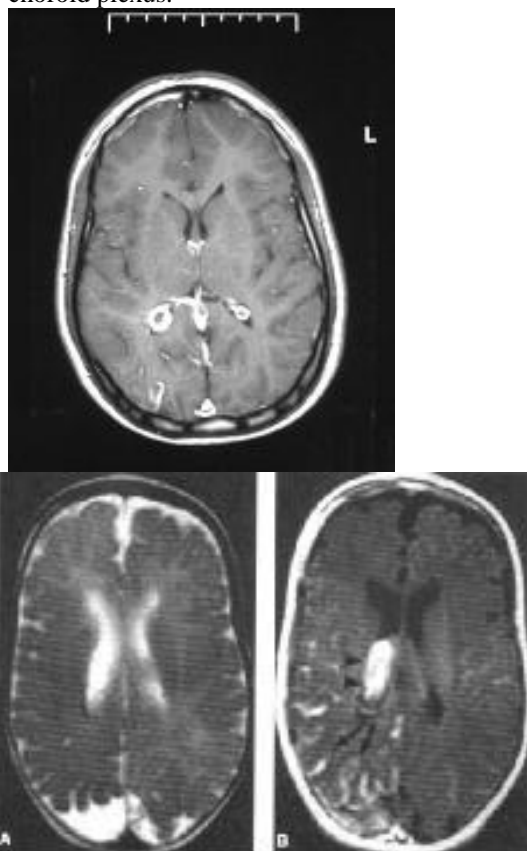


MRI:

- T2 - hyperintense leptomeningeal thickening and enhancement.
- **gadolinium enhancement of angioma** (appears as enhancement of subarachnoid space, medium covering cortical gyri and filling sulci) – early diagnosis!
 N.B. enhancement is difficult to assess on CT in presence of calcification!
- adjacent **cortical atrophy**, accelerated / delayed myelination around angioma.

- enlarged ipsilateral choroid plexus (size correlates with angioma extent) & enlarged draining transcortical draining veins.
- progressive sinovenous occlusion → lack of superficial cortical veins (on MRV).

Contrast T1-MRI - right cerebral atrophy, enhancing right occipital cortex, enlarged right choroid plexus:



Contrast T1-MRI - intense pial enhancement and subjacent cerebral atrophy:



SPECT: hyperperfusion (in infancy, before first seizures) → classic *hypoperfusion* of involved hemisphere (after 1 year of age, even in those without epilepsy).

- steal phenomenon (during seizures).

PET – *hypometabolism*.

EEG – marked *voltage attenuation* in region of angioma; background suppression (74%); polymorphic delta activity; epileptiform discharges in remainder of cortex (22%).

Biopsy – typically not performed.

TREATMENT

1. Seizure control improves neurologic outcome!

N.B. epilepsy surgery should not be delayed (ideally – during infancy)!

controversy regarding optimal timing of surgery: early surgery might preempt cognitive deficits from chronic, intractable epilepsy vs. early surgery might subject some patients to surgery risks.

- complete seizure control is achieved in 10-50% patients; refractory seizures occur in 11-83%.
 - epileptogenic region is located in cortex adjacent to angioma.
 - localize *area of seizure onset* preoperatively by video EEG, ECOG, functional neuroimaging (e.g. ischemic regions may act as epileptogenic foci that may not be detected by CT / MRI).
- 1) **Focal cortical resection** – when epileptogenic region is smaller and more localized.
 - 2) **Hemispherectomy** (anatomical hemispherectomy or functional hemispherectomy or hemidecortication) – for extensive, unilateral epileptogenic region; hemispherectomy is more successful if done during infancy!
 - 3) **Corpus callosotomy** – for bilateral disease (intractable atonic or tonic seizures leading to secondary injury).
 - 4) **Vagus nerve stimulation (VNS)** – for those who are not candidates for other surgical procedures.
2. Prophylactic daily low-dose **ASPIRIN** - for headaches, stroke-like events (may be result of progressive venous thrombosis).
N.B. varicella and yearly influenza immunizations (varicella / influenza + aspirin → Reye syndrome)
 3. Cosmetic **laser therapy** ASAP for **port-wine stain** (earlier treatment - fewer laser flashes needed to remove lesion).
 4. **IOP control**

BIBLIOGRAPHY for ch. “Phakomatoses” → follow this [LINK >>](#)