Subdural Hematoma

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EPIEMIOLOGY

• men : women = 3:1
• most patients > 70 yrs.
• more common than EDH.

ETOLOGY

1. Vigorous head motion (acceleration-deceleration injury*) – may be trivial!
2. Spontaneous (30% of chronic SDH, i.e. intrinsic susceptibility – prone to recur)
   1) congulopathies
   2) (recurrent) CSF leak / CSF shunts causing ventricular decompression (→ stretching of bridging veins) and low ICP (intracranial venous congestion – seen on MRI as meningeal enhancement)
   3) intracerebral hemorrhage, ruptured intracranial aneurysm (blood may dissect into subdural space, esp. PComA → convexal SDH; distal ACA → parafalcine SDH)
   4) intermittent bleeding from dural AVF (recurring subdural hematomas)
   5) bleeding from intracranial tumors
   *e.g. falls & assaults (% 72% SDH cases!); vehicular trauma (only % 24% - automobile absorbs some of energy - so deceleration rate is less), shaken baby syndrome

PATHOLOGY, PATHOGENESIS

- movement of brain relative to skull – rupture (vs shearing mechanism) of subarachnoid veins (CSA) – subdural space – run from cortical surface to dural sinus; commonly found along sagittal sinus and around anterior tip of temporal lobe.
  - rarely, bleeding source may be cortical arteries or oozing brain laceration.

LOCATION

1) along cerebral convexities - most common! (most often frontotemporal).
2) along interhemispheric fissure and tentorium* (often associated with shaken baby syndrome).
3) posterior fossa (<1%) - cerebellum undergoes little movement; most SDHs here are result of parenchymal cerebellar injury – posterior fossa SDHs have highest mortality!
4) subdural space (unlike epidural space) is not confined by dura mater, dura mater is attached to inner table of skull.

CLASSIFICATION

Acute SDH manifests during first 72 hours; most common type of traumatic intracranial hematoma (5-30% of severe head injuries; 1% of mild head injuries)

- commonly (> 50%) associated with extensive primary brain injury!!! (vs. EDH) - diffuse parenchymal injury, contusions, lacerations, intracerebral hematomas - play major role in outcome!!!
- more common in elderly and in infants (both have larger subarachnoid space - allows for more movement between brain and dura).

Chronic SDH manifests in elderly (vs. EDH) - average age of trauma patient without acute SDH – 26 years; average age of patient with acute SDH – 41 years.
- mortality: simple SDH (if no other brain injury) = 20%; complicated SDH (e.g. with contusions) = 60%.

Subacute SDH manifests between 3-20 days old (surgical literature favors > 3 days; radiological literature favors > 7 days).
- most common after age 50 with apparently insignificant head trauma.
most are derived from subdural hygroma; minority develop from untreated acute SDH.

• commonly associated with cerebral atrophy.

• risk factors for chronic SDH - elderly with cerebral atrophy, chronic alcoholism, epilepsy, bleeding disorders, arachnoid cysts, cardiovascular disease (hypertension, arteriosclerosis).

• 8.7-32% are bilateral.

• mortality ≈ 5-10%.

• small SDHs often spontaneously resorb; larger SDHs liquify (in ≈ 1 week) and form encapsulating vascular membranes (fibroblasts grow from dural surface and form thicker outer membrane by about 7 days, and thinner inner membrane after 2-3 weeks), rarely calcifies.

- blood in chronic SDH has liquid consistency, typically resembling crank case oil (can be drained through burr holes!).

- membrane consists of many fragile capillaries, intact and lysed RBCs, hemosiderin-laden macrophages, and granulation tissue.

- organized hematoma is firmly attached by fibrous tissue to dura and is not at all adherent to arachnoid (arachnoid does not contribute to membrane formation).

- at some point, critical mass is reached (hematoma assumes biconvex shape and becomes symptomatic):
  a) bleeding into chronic SDH (small recurrent hematomas from thin-walled vessels within membrane due to repeated minor trauma); up to 45% chronic SDHs rebleed; risk of rebleeding is greatest in first few months.

  b) osmotic swelling – due to blood break down and increased protein content (draws water osmotically across subdural membrane → clot enlargement).

- dura has been reflected above to reveal bridging veins:

- data has been reflected back (with small portion visible at lower right) to reveal subdural hematoma:

- here is bilateral chronic subdural hematoma; blood clots are brown to tan because of organization:
CLINICAL FEATURES

A. Clinically silent.

B. Brain compression (slow venous bleeding enables large hematomas to form before clinical signs appear) - can progress rapidly or slowly.

Most acute SDHs manifest within 48 hours.
- ≥ 50% patients are unconscious from time of injury; (SEMIULCER INTERVAL is observed in 30-70% cases).
- There may be focal signs* (due to prolonged brain tissue compression under hematoma), but often clinical manifestations are nonlocalizing (due to ICP); later, brain herniation may develop.

*deficits are soft (not as profound as in other hematomas).

Hemostasis

A. W. B. Saunders Company; ISBN 0721673356

Source of picture:

Clinically silent major vessels.

angiographic signs of SDH appear)

Chronic SDH

Brain compression can cross suture lines and continue along falx and tentorium (do not cross midline!).

- Osmotic swelling (anemia)
- Hyperacute clot (< 1 h old)
- Active bleeding

small hematomas may not be depicted because attenuation similar to adjacent inner table of skull (H: wider CT window and level, e.g. 240 and 80 HU).

Subacute SDH: (isodense*) important signs - effacement of cortical sulci, displacement of gray matter→white matter junction (‘buckling’); membranes are not vascularized.

- Better visualization - MRI (high signal on T1) or contrast-enhanced CT (opacification of cortical vessels - definition of brain margins).

Chronic SDH: (hyperdense*) (15-30 HU, i.e. isodense to CSF); vascularized membranes enhance with contrast.

*compared to brain.

Diagnosis

Rule of thumb: blood remains denser than brain for 1 week, and in less dense after 3 weeks.

underlying brain is flattened (mass effect)

and subarachnoid space is often clear.

absent midline shift - suspect contralateral mass (e.g. ≥ 20% chronic SDHs are bilateral); useful sign - venricular frontal horns lie closer together ('rabbit's ear' configuration).

excessive midline shift - suspect underlying cortical edema.

in interhemispheric SDH, falx cerebi appears thickened and irregular.

- Interhemispheric SDH may mimic SAH (subarachnoid blood clears after several days; SDH remains wedge-shaped, smooth-bordered, hypodense). ‘comma shape’ on axial CT.

- Posterior fossa SDH does not cross midline or extend above tentorium (vs. EDH).

- Temporal and frontal SDHs are better detected on coronal MRI (than on axial CT).

rebleeding into subacute/ chronic SDH makes hematoma biconvex and heterogeneous density (mixed old and fresh blood, sedimentation levels) - in general, looks like EDH with heterogeneous density.

Size of extra-axial hematoma is more important factor than whether blood is epidural or subdural in location!

Suspect child abuse! (esp. if posterior interhemispheric & tentorial SDHs)

- Focal swelling of chronic SDH may make hematoma biconvex and heterogeneous density - in general, looks like EDH with heterogeneous density.

MRI is most sensitive imaging test! (esp. in subacute and chronic phase).

- angiographic signs of SDH - mass effect between skull and brain with away dislocation of major vessels.

N.B. blood pressure is less and heart rate is more rapid in acute SDHs.

- Absence of clear history of trauma → angiographies (search for ruptured aneurysm or dural AV fistula).

- Size of extra-axial collections:
  - T1 & T2-MRI: bilateral subdural SDHs (increased signal intensity; areas of intermediate intensity represent more acute hemorrhage into subacute collections).
Skull fracture with adjacent small acute SDH (window and level values are widened over standard values to aid detection):

MRI - subacute SDH with extension into anterior interhemispheric cistern (note that sutures do not contain spread):

SDH with adjacent SAH due to ruptured MCA aneurysm:

SDH due to ruptured right PComA aneurysm:

Right frontal - subacute SDH - note displaced gray matter–white matter junction, and midline shift:

Subacute–on–chronic SDH with blood–fluid level (acute hemorrhage into chronic collection)
Acute-on-chronic SDH:


Subacute SDH - less dense than brain but denser than CSF; it is denser posteriorly, midline displacement is greater than would be expected from size of lesion - suggests extensive underlying swelling; contralateral (left) ventricle is dilated.

Source of picture: "WebPath - The Internet Pathology Laboratory for Medical Education" (by Edward C. Klatt, MD)

Bilateral SDHs, right greater in size than left:

Source of picture: "WebPath - The Internet Pathology Laboratory for Medical Education" (by Edward C. Klatt, MD)

Acute SDH:

MRI - bilateral SDHs (arrow) with suboccipital extension:
Subdural Hematoma

Interhemispheric acute SDH:

Bilateral chronic SDHs; midline shift is absent:

Chronic SDH with no mass effect:

Bilateral chronic SDHs with acute rebleeding:

Acute SDH extending over entire left hemisphere; sedimentation level is seen (patient has clotting dysfunction):
Subdural Hematomas:

A) Noncontrast CT: inward displacement of gray-white matter junction of left cerebral hemisphere; small sedimentation level is apparent in posterior portion.

B) Contrast CT at same level as A: good visualization of lateral margin of left cerebral hemisphere (opacified cortical veins).

Acute and subacute SDHs:

A. T1-MRI: large fluid collections (white arrows) consistent with large subacute SDHs.

B. T2-MRI: hyperintense signal (white arrows) representing subacute blood and hypointense signal (black arrows) representing more recent hematoma.

Calcified SDHs:

A. In frontal view, bilateral shell-like calcifications form cast of cerebral hemispheres.

B. In lateral view, outer calcified membranes are near bony skull, and inner membranes are separated from outer by relatively clear zones.
**TREATMENT**

In all cases, hematoma complete resolution should be documented (conservatively treated acute SDH can evolve into chronic SDH).

**CONSERVATIVE MANAGEMENT**

- surgical drainage is not required in many cases (acute SDH may disappear spontaneously, but may evolve into subacute or chronic lesion!)- managed with serial CT and close neurological observation in a neurological ICU.
- seizure prophylaxis and other measures → see p. TrH1

**CHRONIC SDH**


- Dr. Okonkwo (UPMC) gives MEDELEDEEEROKLLODOS; Dr. Day gives DXAMETHASON 2 mg q8hrs for 2 weeks, then tapers based on repeat CT findings.

- EG-1964 (Edge Therapeutics, Inc.) - polymer-based filament that contains APROTININ - pancreatic trypsin inhibitor.
  - indicated to prevent rebleeding and reduce the need for blood transfusions following cardiac bypass surgery
  - IV administration has serious thrombotic side effects
  - EG-1964 delivers sustained dose of aprotinin over 21-28 days directly to site of SDH

**HEMATOMA EVACUATION**

**ACUTE SDH**

Guidelines “Surgical management of acute subdural hematomas” in Neurosurgery. 2006 Mar 56;3 Suppl 5:S16-24

- indications for ASAP* surgery: also see p. TrH1
  a) acute SDH with a thickness > 10 mm, regardless of the GCS score
  b) midline shift > 5 mm, regardless of the GCS score.
  c) GCS < 9 and GCS decreased between the time of injury and hospital admission by ≥ 2 points
  d) GCS < 9 and asymmetric or fixed and dilated pupils
  e) GCS < 9 and ICP > 20 min Hg

- acute SDH in coma (GCS < 9) → ICP monitoring.

- surgical evacuation of an acute SDH should be performed using a craniotomy ± bone flap removal and duraplasty. see p. Op320

*delay for 4 hours is a benchmark of neurosurgical care:
SUBDURAL HEMATOMA

Seelig et al. (1981)

Wilberger et al. (1991)

Wilberger et al. (1991) study also revealed that the appropriate strategies to prevent secondary brain injury may be more important than the timing of surgery in determining outcome (i.e. an increased focus on how to manage ICP during the interval between injury and surgery).

CHRONIC SDH

• any coagulopathy must be reversed ASAP.
• must be surgically evacuated if symptomatic* (*significant mass effect on imaging):
  A. Burr hole craniostomy ("burr hole washout") – procedure of choice.
  B. Twist drill craniotomy – at bedside for very sick patient.
  C. Craniotomy – indicated for:
    a) multilocular / calcified SDHs.
    b) burr hole / twist drill drainage failures.

N.B. some experts advocate craniotomy as first choice for cSDH but studies show that all results (complications, dispo, recurrences requiring reoperation*, mortality) are worse than with BHWO.

*24% (vs. 6-7% for BHWO)

Postoperatively see p. Op32 >>

PROGNOSIS

Most important prognostic factors:
1. Concomitant primary brain injury
2. GCS score
3. Age (esp. > 40 yrs).
4. Time from trauma to surgical evacuation of hematoma (esp. > 4 hours).

After surgical evacuation, subdural hematoma recurs in 5-30% patients.

Chronic SDH increases mortality 17-fold at 1 year.

SDH IN INFANTS

NEWBORNS

• SDH was once considered most common intracranial birth injury (but now ↓ with improved obstetric care).
• in majority of cases, bleeding is BILATERAL and located over dorsolateral surfaces of frontal and parietal lobes.
• clinically: seizures, pallor, tense anterior fontanel, rapidly enlarging head, hypotonia, poor Moro reflexes.
  - may be abnormal at birth (no spontaneous respiration, severe hypotension, seizures, retinal hemorrhage).
  - initial manifestation may be generalized seizures within first 6 months of life.
  - acute cases may progress to herniation.
• diagnosis – ultrasound, CT, funduscopic (50% show retinal or subhyaloid hemorrhages).
  - if SDH interfered with brain growth, skull vault may be thick, with paucity of convolutional impressions, and hypertrophy of acri cells and paranasal sinuses.
  - calcification streaks / plaques, often parallel to vault, may be visible in capsule of chronic SDH.
• treatment – evacuation through craniotomy.

Ultrasound – left echogenic acute subdural hematoma (H), associated with right subarachnoid anechogenic effusion (E). Falx cerebi (arrow) remains straight.
OLDER INFANTS

- SDH is most common intracranial lesion in children < 2 years:
  a) hibakr baby syndrome!! (chronic SDH in infants who do not yet walk) see p. TiH20 >>
  b) complication of shunt procedures
  c) bleeding disorders.
  - clinicala: macrocrania (symmetrical or asymmetrical), tense anterior fontanel, lethargy / irritability, seizures, poor feeding, vomiting, failure to thrive
  - diagnosis: CT, diagnostic subdural tap (should be done bilaterally, even if positive on one side).
  - treatment: repeated daily subdural taps monitored by CT, head circumference measurements.
    - if > 10 taps are done (symptoms persist after 2 wk of daily drainage) → surgical treatment (e.g. subdural-peritoneal shunting or subdural-subgaleal shunting for 6 months; historically → subtemporal craniectomy → to let fluid drain into pterygoid fossa).
  - removal of membranes was once thought to be important to avoid brain growth restriction, but this no longer seems necessary.
  - 25% have some psychomotor retardation.

SUBDURAL HEMATOMA

- anterior fontanelle becomes effectively closed between 9 and 18 months.
- equipment - sterile prep and drape, gloves, razor, blunt short-beveled spinal needle with stylet (20 G, 1½ or 2½ inch), manometer, CSF collection tubes, and local anesthesia (if desired).
  - scalp is shaved anterior to ears (over lateral margins of anterior fontanelle).
  - restrain infant by bundling him in sheet; supine, head firmly held by attendant (avoid excessive neck flexion).
  - raise skin wheal of local anesthetic at puncture site.
  - insert needle through skin at extreme lateral limit of anterior fontanelle where it meets coronal suture (i.e. at least 2-3 cm from midline - to prevent sagittal sinus injury).
    - use Zigzag puncture to prevent later fluid leakage (puncture dislocated skin at right angle, then aim needle laterally).
    - dura is entered with sudden "popping" sensation.
    - cerebral cortex is ≈ 1.5 cm from skin surface (attachment of hemostat 5-7 mm from beveled end of needle should provide adequate safeguard).
  - remove stylet - subdural fluid is allowed to drain spontaneously (fluid is never aspirated - risk of drawing pial vessels into point of needle).
    - only 10-20 mL of subdural fluid should be removed from each side at one time (removing larger amounts may precipitate rebleeding or shock).
    - if pial vessel is punctured, bleeding will usually cease spontaneously.
    - pressure is measured with manometer.
  - remove needle + apply pressure + firm sterile dressing + place in sitting position (to prevent leakage).
  - if continued leakage from puncture site → apply collodion-impregnated cotton fluff over puncture wound + elevate head 20-30°.
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SUBDURAL TAP

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  - repeat on opposite side.
  - continued leakage from puncture site → apply collodion-impregnated cotton fluff over puncture wound + elevate head 20-30°.

BIBLIOGRAPHY for ch. “Head Trauma” → follow this LINK >>