Neurosurgical Management of Intracerebral Hemorrhage

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Objectives

- Understand Intracerebral Hemorrhages (ICH)
- Explore the timing/administration of appropriate surgical treatment for ICH
  - Also, Large ischemic stroke
- Understand STICH and MISTIE: ICH Trials
- Know when to consult Neurosurgery
  - ASAP
Why so important?

- Intracerebral hemorrhage (ICH) has been the stroke subtype that has defied attempts to find a scientifically proven effective therapy.

- Possible treatments of acute ICH include:
  - (1) slowing or stopping of the bleeding during the first several hours after onset
  - (2) removal of the accumulated hematoma to prevent the mechanical complications of mass effect as well as the toxic effects of blood on the surrounding brain parenchyma.
Top Intracerebral Emergencies

- **ICH**
  - Supratentorial
  - Basal Ganglia/Thalamus
  - Cerebellar (Posterior Fossa)

- **Stroke (Actually, Ischemic)**
  - Large MCA Stroke
  - Cerebellar Stroke

- Traumatic Brain Injuries (TBI)
  - EDH
  - SDH
  - SAH

- SAH
  - secondary to Aneurysmal Rupture
Etiology of ICH

- Hypertension
- Blood thinner therapy
- Vascular abnormality
  - AVM
  - Aneurysmal rupture
- Head trauma
- Bleeding disorders
- Tumors
- Amyloid angiopathy
- Drug usage
ICH Continued…

COMMON CAUSES

- Lobar hemorrhages are often associated with structural changes such as cerebral amyloid angiopathy, arteriovenous malformations (right), or brain tumors.

- Rupture of diminutive arteries within the brain likely from uncontrolled HTN (left) usually cause BG, thalamus, etc.
  - As blood collects, a hematoma or blood clot forms causing increased pressure on the brain.

- Amyloid Angiopathy in Older patients
ICH: Intracerebral (Intracranial) Hemorrhage
ICH

- Intraparenchymal: Bleeding within the brain
- The most common locations of hypertensive ICH are:
  - basal ganglia (caudate nucleus and putamen)
  - thalamus
  - deep cerebellar nuclei
  - midbrain
  - pons
  - lobes
- Sometimes, located at site of old CVA (Hemorrhagic transformation of infarct)
Surgical treatment of spontaneous intracranial hemorrhage

- Supratentorial hemorrhage
- Posterior fossa hemorrhage
- Intraventricular hemorrhage
- Minimally invasive surgery role
When do we treat surgically?

- Controversial
- Surgery may lower the morbidity from rebleeding (especially if an aneurysm or AVM is identified as cause), edema, or necrosis from mass effect
- Rarely causes neurologic improvement
- STICH
STICH

- An important milestone in the role of surgical treatment for ICH
- Completed the largest ever randomized treatment trial of ICH

- Thus, the STICH Trial is primarily a trial of **CRANIOTONY** for ICH removal.
Surgical Trial in Intracerebral Hemorrhage (STICH)

- Mendelow et al. Lancet. 2005

- Randomized 1033 patients with supratentorial hemorrhage (lobar or ganglionic hematoma) to:
  - Early surgery within 72 hours of ictus) versus standard of care (i.e., medical management with delayed surgery if necessary)
  - 83 centers in 27 countries were randomized to early surgery (503) or initial conservative treatment (530)

- RESULT: No difference in favorable functional outcome at 6 months was found ($p = 0.414$)
  - STICH investigators concluded that “patients with spontaneous supratentorial ICH in neurosurgical units show no overall benefit for early surgery when compared with initial conservative management.”

- ** However, the subgroup of patients with superficial ICHs (lobar hemorrhage within 1 cm of the cortical surface) who underwent surgery had better outcomes. This result prompted a second trial, STICH II
STICH II

- 2015 Follow up

- Aimed to randomize patients with superficial lobar hematomas (10–100 ml) to early surgery versus medical management with delayed surgery if necessary

- Patients with IVH or coma were excluded.

- STICH II found no difference in mortality or severe disability with early surgery ($p = 0.37$).

- Confirms that early surgery does not increase the rate of death or disability at 6 months and might have a small but clinically relevant survival advantage for patients with spontaneous superficial intracerebral hemorrhage without intraventricular hemorrhage.
What does the STICH tell us about the role of surgical removal of ICH?

- A fair summary is that except for possibly those with superficial ICHs (about 1 cm from surface), craniotomy at 1 day or longer after onset is not better than initial conservative medical treatment with or without later craniotomy for patients who have deterioration.

- “Our results suggest that the poor prognosis patients (GCS of 9-12) are better off with early surgery. But if they fall into the good prognosis group, the best option is to just watch them, and only operate in those that later deteriorate.”- Mendelow
GUIDELINES FOR Considering Surgery vs Medical Management

**NONSURGERY**
- Minimally symptomatic lesions (alert w/subtle hemiparesis, GCS>12)
- Situations with little chance of good outcome
- Severe coagulopathy or other big medical disorder
- Basal ganglion (putaminal) or thalamic hemorrhage

**SURGERY**
- Marked mass effect, edema, MLS
- When sx appear to be due to increased ICP or mass effect (i.e. compression from the clot or surrounding edema)
- Sxs attributable from brain injury from the hemorrhage unlikely to be reversible with surgery
Surgery cont.:

- Moderate size hematomas (10-30cc)
- Persistent elevated ICP despite medical
- Rapid deterioration (esp with signs of brainstem compression)
  - In pt considered to benefit from intervention
- Favorable location: cerebellar!, external capsule, nondominant hemisphere
  - Lobar is disputable
- Young patient (age<= 50 yrs)
Treatment for deep ICH

- The mainstay of treatment is medical, with control of hypertension and attempts to prevent secondary cerebral injury.
Deep ICH

- Thalamic hemorrhages that tend to destroy the internal capsule (IC) are more likely to produce hemiplegia than those lateral to IC.
Intraventricular Hemorrhage (IVH)

- Present in approximately 45% of patients with spontaneous ICH
- Isolated IVH (primary IVH) occurs rarely but more often is the result of secondary extension of a parenchymal hematoma into the ventricular system.
- Associated with a lower probability of favorable outcome compared with absence of IVH (15% vs 31%, \( p <0.00001 \))
- The presence of blood in the ventricles can interrupt the normal cerebrospinal fluid (CSF) flow and cause obstructive (noncommunicating) hydrocephalus and increased ICP.
Intraventricular Hemorrhage

Frontal Horn
Temporal Horn
Lateral Ventricle

Frontal Third Fourth
Occipital Horns
Treatment of IVH

- Placement of an EVD to drain CSF and monitor ICP should therefore be considered in patients with acute hydrocephalus/IVH and GCS $\leq 8$ or with signs of transtentorial herniation.

- Usually placed in the lateral ventricle contralateral to the hemorrhage.

- Prognosis of patient with significant volume of IV blood poor.
In general, ventriculostomy done when:

- IVH causing acute obstruction of third ventricular outlet
  - Acute hydrocephalus
- GCS ≤ 8 or with signs of transtentorial
- For ICP management
Posterior Fossa Hemorrhage

- Hemorrhage involving the posterior fossa
  - (cerebellum or brainstem)

- Associated with life-threatening complications:
  - Acute hydrocephalus secondary to fourth-ventricle compression and direct brainstem compression
  - And/or herniation through the foramen magnum.

- Carry a relatively good prognosis if timely evacuation and control of hydrocephalus can be obtained
Posterior Fossa

- In the case of neurological deterioration, hematoma drainage ± craniectomy should be strongly considered.

- Absent brainstem reflexes and flaccid quadriplegia: no intensive therapy indicated; obtain brain death exam

- Insertion of EVD alone for treatment of cerebellar occupying lesions remains controversial because of the theoretical risk of upward herniation and is not recommended by the AHA guidelines
  - Patients with hydrocephalus can benefit from ventricular catheter, but if overdrain, can get upward cerebellar herniation
  - Most cases with hydro require evacuation of clot anyway
Management of posterior fossa hematoma

Treatment strategies include:

- Posterior fossa (suboccipital) decompressive craniectomy, external ventricular drain (EVD) insertion, or conservative management.

- GCS $\geq 14$ & hematoma < 4 cm diameter: treat conservatively

- GCS $\leq 13$ & hematoma $> 4$ cm diameter: treat surgically
Ischemic Stroke

- **Malignant MCA territory Infarction**
  - Distinct syndrome in up to 10% stroke patients
  - Findings: hemiplegia, forced eye and head deviation
  - CT findings within 12 hours of major infarct
  - Most develop transtentorial herniation within 2-4 days
Malignant MCA Stroke Treatment

- Hemicraniectomy
  - May reduce mortality to as low as 32% in nondominant hemispheric strokes with reduction of hemiplegia
  - In dominant strokes, mild-moderate aphasia; better results from early surgery (within 48 hours)
- Again, no firm indications
- Guidelines:
  - Age < 70 years
  - Consider strongly in nondominant hemisphere (usually right)
  - Clinical and CT e/o acute, complete ICA or MCA infarcts
  - Direct signs of impending or severe hemispheric swelling
    - Severe post admission neuro deterioration usual event that triggers surgery
Ischemic Stroke continued...

- Cerebellar Infarcts:
  - Unlike supratentorial masses that have already caused herniation, patients in deep coma from direct brainstem compression who were operated on quickly made a useful recovery.
  - Surgery: suboccipital decompression to enlarge foramen magnum, dura opened and cerebellar tissue exudes like toothpaste and aspirated.
Minimally Invasive Surgery (MIS)

- What STICH left unanswered is what role less invasive surgery to remove ICH, particularly at earlier time windows, has.

- Several small randomized trials of less invasive surgical approaches, particularly using stereotactic localization, have reported positive outcomes for surgical removal as compared with medical management.

- Approaches include:
  - Mechanical clot disruption (i.e. ultrasonic catheter tip)
  - Endoscopic removal
  - Injection of thrombolytics for clot dissolution

- Moreover, open surgical evacuation of an ICH can be associated with poor patient stability, additional brain injury, and frequent rebleeding during postop period
  - Craniotomy, according to the results from multiple trials, does not necessarily improve functional outcome after intracerebral hemorrhage.

- The goal: reduce hemorrhage volume and mass effect enough to hasten and improve recovery
NEW ALTERNATIVES

- New approaches for hematoma drainage have emerged in the last decade, including stereotactic aspiration of clot ± thrombolysis or endoscopic procedures.
Minimally Invasive Surgery Plus rtPA for ICH Evaluation (MISTIE) Study

- In the randomized, dose-finding study
  - Patients had placement of the catheter into the hematoma and instillation of the first dose of recombinant tissue plasminogen activator within 24 hours of symptom onset.

- Phase 2 trial that was done in 26 hospitals in the USA, Canada, the UK, and Germany.

- Randomized 123 patients aged 18-80 years with a non-traumatic (spontaneous) intracerebral hemorrhage of 20 mL or higher to standard medical care or image-guided MIS plus alteplase (0.3 mg or 1.0 mg every 8 h for up to nine doses) to remove clots using surgical aspiration followed by alteplase clot irrigation.

- Primary outcomes were all safety outcomes: 30 day mortality, 7 day procedure-related mortality, 72 h symptomatic bleeding, and 30 day brain infections
MISTIE

- Showed that blood clots in the brain can be successfully removed quickly and safely when compared to medical management alone.

- Reduces the rate of death and improves the patient's neurologic functioning and quality of life in the year following this type of hemorrhagic stroke.
Cho et al. 2006 compared three approaches (neuroendoscopy vs stereotactic aspiration vs craniotomy) in a randomized trial of 90 noncomatose patients with ganglionic hematomas.

• There was no difference in mortality, but patients treated endoscopically had better functional outcomes within 6 months of surgery as assessed by functional independence measure score, Barthel index score, and muscle power.
Techniques such as neuroendoscopy or intraventricular thrombolysis (IVT) have been investigated.

The Clot Lysis Evaluation of Accelerated Resolution of Intraventricular Hemorrhage (CLEAR-IVH) trial demonstrated that the use of low-dose recombinant tissue plasminogen activator (r-tPA) had an acceptable safety profile in patients with IVH, as well as being beneficial in accelerating the removal of clot from the ventricular system.
Minimally Invasive cont.

- We are now getting to different arms of these trials.

- MISTIE III: assessing usefulness of stereotactic catheter placement into intraparenchymal hematomas followed by **direct injection of rt-PA for 3 days** and aspiration
  - Pending results

- CLEAR III and IV: preliminary primary outcome comparing the use of EVD combined with intraventricular injection of rt-PA to EVD plus intraventricular injection of normal saline (placebo) for the treatment of IVH, has been completed has not shown a sig difference
  - Use of rt-PA was associated with a 10% reduction in mortality in the whole population ($P < .007$) among other conclusions
Conclusions

The future use of minimally invasive surgery is promising; however, there is a level of uncertainty currently in its utility as many neurosurgeons are not trained in these techniques (i.e. endoscope, stereotactric procedures, etc.)

- Because of the lack of randomized evidence-based trials in even the most basic surgical procedures, we can only make surgical decisions based on a few guidelines

- Much more to come in this field

- I will stick to operating for now on selective patients who demonstrate the possibility of good functional recovery without risking their lives and/or worsening their conditions in the OR and after having a very thorough conversation with the family
CASE

You are the On-call Neurosurgeon
You are the on-call neurosurgeon

- 64 y.o F transferred from an OSH for ICH. According to her coworkers, she experienced a horrible headache the day before, but today had severe vomiting and disorientation.

- VS: BP 133/84 HR 76

- PMHx: HTN, Gout, Hyperlipidemia, DM

- Medications: ASA, Allopurinol, Colchicine, Losartan, Metformin, Meloxicam, Simvastatin

- Exam:
  - Awake, Alert, Not oriented
  - Slurred speech, incomprehensible words, occasional words in Tagalog, some comprehension of speech
  - Hitting head repeatedly on left side
  - MAE well
  - Will not cooperate with some aspects of exam
Steps

- Assess GCS
  - GCS E4M6V3
- Look at VS
- Make suggestions in ED
  - Keppra
  - 3% at 30cc/hr
- Any other tests
  - CTA
- Decide on surgery vs medical management...
GCS

- Max: 15 (E4M6V5)
- Min: 3 (E1M1V1)

**Eye Opening**
- 4: opens spontaneously
- 3: opens to voice
- 2: opens to pain
- 1: not opening

**Motor**
- 6: Obeys commands
- 5: Localizes
- 4: Withdraws
- 3: Flexion to pain
- 2: Extension to pain
- 1: No motor

**Verbal**
- 5: Oriented
- 4: Confused
- 3: Inappropriate words
- 2: Incomprehensible Sounds
- 1: No verbal response
- T: Intubated
What I chose...

- Medical management
  - Tight BP control
  - Pain management without sedation
  - “cerebral diuretics”
- ICU setting
- She left 4 days later
- Neuro intact
References


- Allan D. Levi M.D., Ph.D. Professor Department of Neurological Surgery University of Miami Lecture Series Neurosurgery ABNS Board Review

- http://radiopaedia.org

- *Greenburg. Handbook of Neurosurgery


- Broderick, Joseph P. “The STICH Trial What Does It Tell Us and Where Do We Go From Here?”
More if you want....
Traumatic Brain Injuries (TBI)

- SDH
- EDH
- Cerebellar Hemorrhage
- SAH
Subdural hemorrhage/hematoma (SDH)

- Acute, Subacute, Chronic
- Collection of blood accumulating in the potential space between the dura and arachnoid of the meninges around the brain.
  - Under dura
- Mainly due to head trauma
- Prognosis varies widely depending on size and chronicity of the hemorrhage.
SDH cont:

- **Clinical presentation**
  - Acute: Young patient with trauma
  - Commonly co-exist with cerebral contusions
  - Most patients (65-80%) present with severely depressed conscious state, and pupillary abnormalities may be seen in ~40% (range 30-50%) of cases.
  - Clinical presentation of subacute/chronic SDH in the elderly is often vague and is one of the classic causes of a pseudo-dementia.
    - A history of head trauma is often absent or very minor.
EDH

- Typically seen in young patients who have sustained head trauma, usually with an associated skull fracture.

- Happens between skull and dura (Thus...epi-)

- Limited by suture insertion
Treatment in ED/ICU for Trauma

- Control the HTN!!!!!!!
  - SBP<150

- I = O
  - 0.9% Saline
  - Ensures appropriate pressure in head

- Obtain an appropriate GCS

- If there is any sign of elevated ICP, give mannitol or hypertonic agent
  - 0.5-1gm/kg of mannitol + lasix
  - 250 cc of 3%, 5%, etc Saline

- TURN OFF THE SEDATION if pt intubated

- If the pt is conversant and VSS, please do not intubate!
Surgery in Extra-axial Spaces

- It is well-accepted practice to remove extradural (EDH) and subdural hematomas (SDH) following traumatic brain injury
Extra-axial Guidelines

- Acute SDH with thickness > 10 mm or midline shift (MLS) > 5mm on CT should be evacuated regardless of GCS

- <10 mm and MLS <5mm should undergo evacuation if:
  - GCS drops by >/= 2 points from injury to admission
  - and/or the pupils are asymmetric or fixed and dilated
  - And/or ICP>20 mmHg

- Monitor ICP in all pts with ASDH and GCS<9

- If meet surgical criteria, evacuate ASAP

- Treatment is Craniotomy with or without bone flap removal
  - With=craniectomy