Cranial burr hole in the patient remote from neurosurgical care

Jason Kurland
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Nothing to disclose

Imposter syndrome I

-I’ve never *done* a burr hole

-I’m a family doc who *practices* EM (among other things) at a tiny rural hospital

Imposter syndrome I

-I've never *done* a burr hole

-I'm a family doc who *practices* EM (among other things) at a tiny rural hospital

-That said, I *had* wondered if we *should* be able to do this at my site and found EM-trained providers at other rural sites were similarly interested

-So, I took a deep dive into the literature, recruited some great IHS EM docs with some experience around burr holes and found out that….

Imposter syndrome II

-many/most EM-residency-trained docs haven't done a burr hole *either*

-when they are done by non-neurosurgeons, it's often a general or trauma surgeon (Rinker et al.)

-EM residencies don't consistently teach it

https://www.acepnow.com/article/emergency-department-trephination-burr-hole-for-epidural-hematoma/?singlepage=1

-*and* many rural sites don't even have the proper equipment

-a 2023 survey of rural Australian hospitals found only *11 of 26 had appropriate instruments* (Raman et al.)

-but then again…

Aussie doctor uses household drill to save boy

A doctor in rural Australia used a household drill to bore a hole into the skull of a boy with a severe head injury, saving his life.

Relief: Nicholas with his parents Karen and Michael Rossi who can't praise Dr Carson enough for his quick-thinking actions

https://www.nydailynews.com/life-style/health/doctor-household-power-drill-bore-hole-boy-skull-saving-life-head-injury-article-1.411600

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So which is it?

Brain surgery only the best trained and equipped should attempt?

or

Cowboy medicine any doc with a Black and Decker can do?

Learning objectives

Review basics of epidural and subdural hematomas

Discuss key prognostic indicators

Discuss evidence for non-neurosurgeon burr holes

Review burr hole procedure

Review a burr hole alternative

Should your site/providers be equipped and trained to do this?

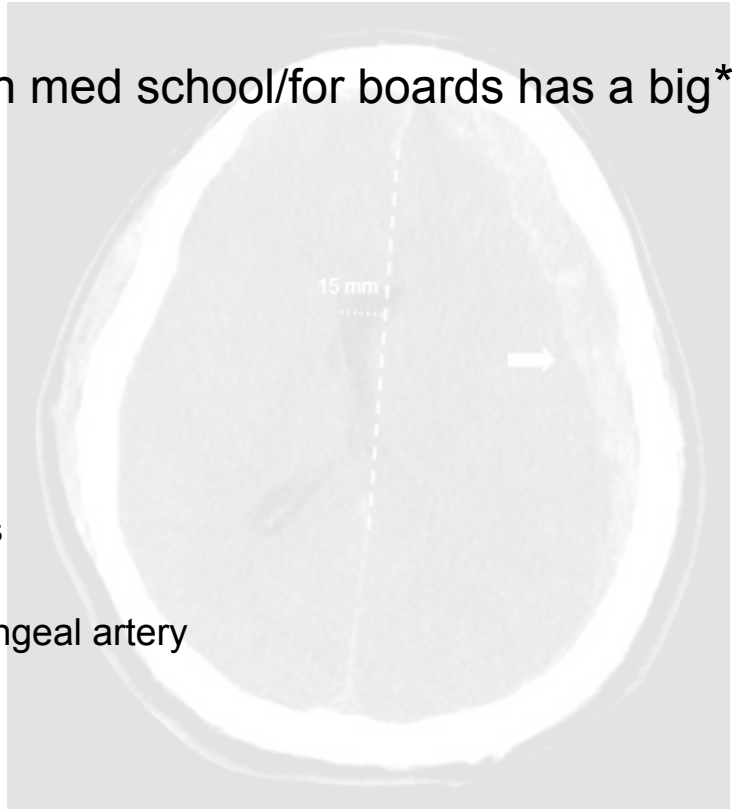
Review basics of epidural and subdural hematomas

(Howard et al.)

(McBride, SDH, UTD)

Review basics of epidural and subdural hematomas

BUT everything we learned about these in med school/for boards has a big*



**for instance:*

-lucid interval in EDH only seen in a minority of cases

-SDH not *necessarily* less dangerous than EDH

-EDH not always associated with fx and middle meningeal artery

  -nor always arterial (can be venous or bone source)

-neither hematoma *always* needs craniotomy

Review basics of epidural and subdural hematomas

What matters (from a burr hole perspective) is that both of these are often relatively isolated and treatable injuries

-they can cause *secondary* brain injury including death via increased ICP/herniation
    -but *the brain itself* is often ok

-compare EDH/SDH to increased ICP due to intraparenchymal bleeding, subarachnoid hemorrhage, tumors or infectious masses, diffuse axonal injury

FIRST, do all the basic stuff:

UTD has good “Rapid Overview”

Review basics of epidural and subdural hematomas

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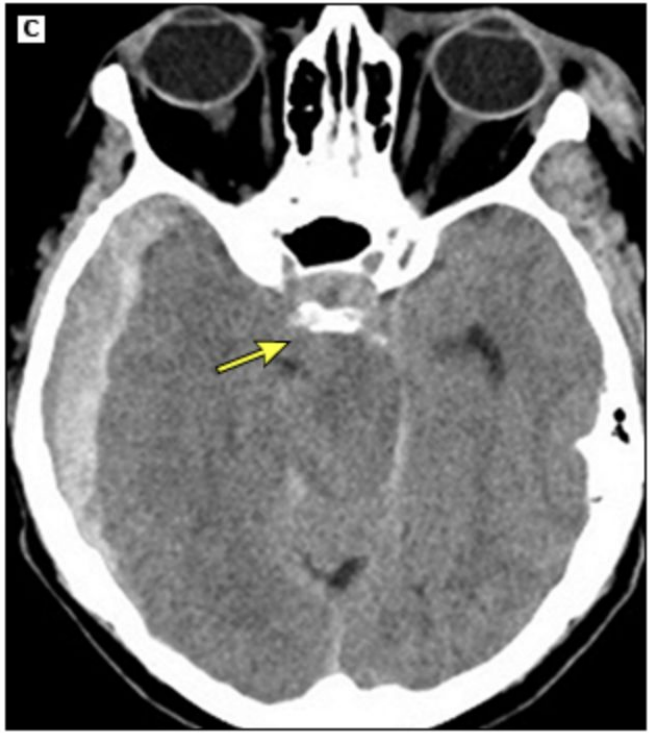
UTD has good “Rapid Overview”

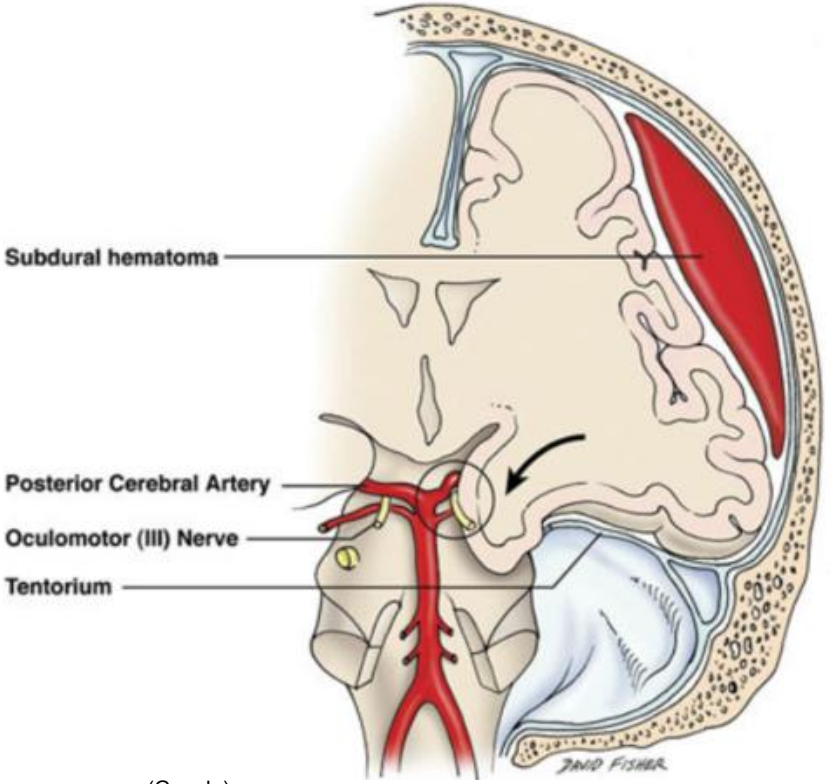
Epidural hematoma in adults: Rapid overview of emergency management

Treatment
▪ Manage trauma patients according to principles of advanced trauma life support*
▪ Perform tracheal intubation for any patient unable to protect their airway, with rapidly deteriorating mental status, or with GCS ≤8
▪ Obtain immediate neurosurgical consultation
▪ Reverse anticoagulation (agent specific):

Review basics of epidural and subdural hematomas: herniation

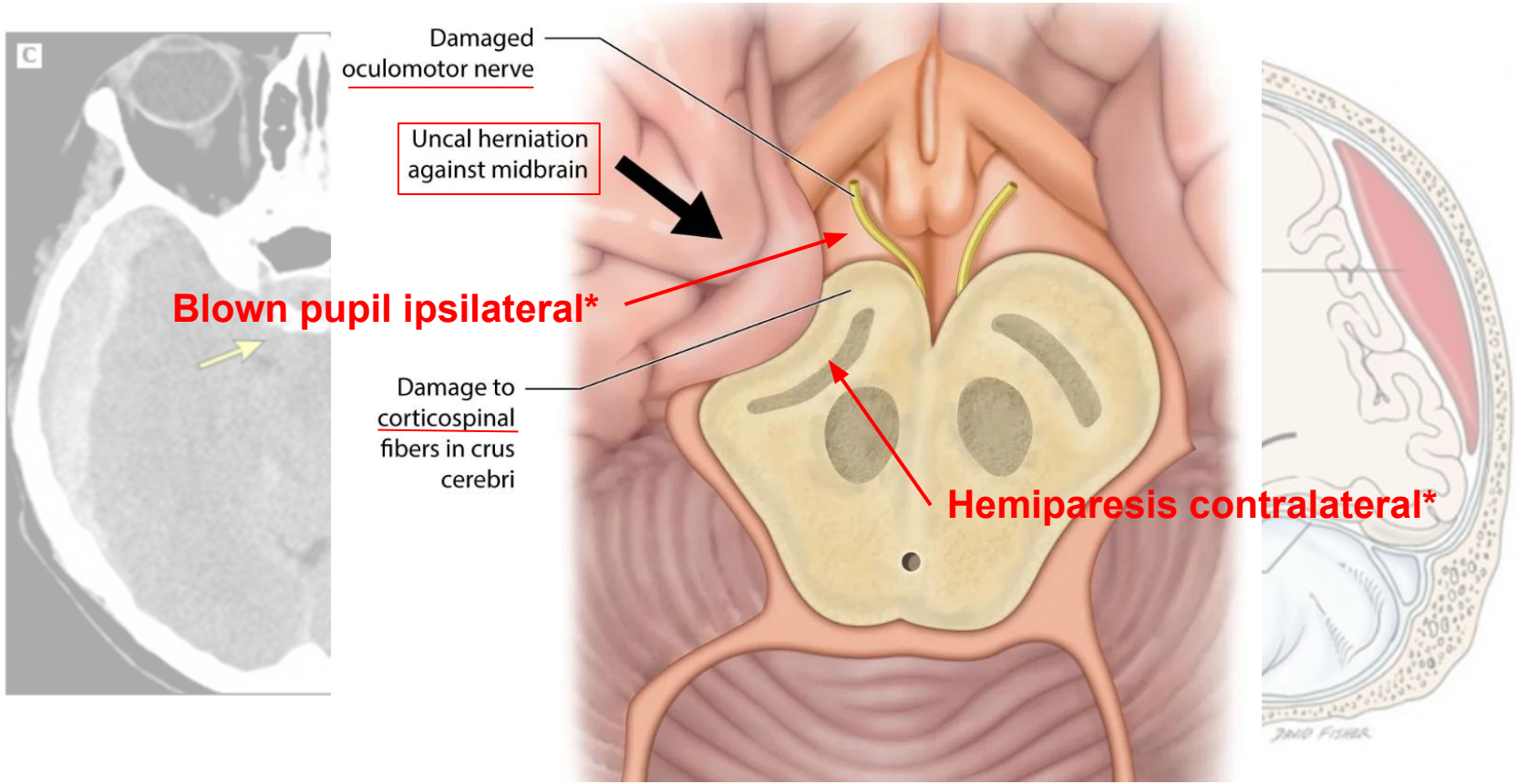


Uncal herniation (obviously)
(McBride, SDH UTD)



(Google)

Review basics of epidural and subdural hematomas: herniation



*Oh, but *sometimes* the blown pupil is contralateral (or bilateral) and hemiparesis *can* be ipsilateral to bleed.

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Key prognostic indicators

EDH often seen in younger, patients with fewer comorbidities⟶better potential outcomes

Many EDHs and SDHs will need to be evacuated

-obviously, neurosurgeon consult up front and ongoing will determine if this is necessary

Consensus is that these patients should see a neurosurgeon (or better an OR) < 4 hours

CT findings, eg “midline shift”, “herniation” or “impending herniation” are cause to consider decompression if pt remote from neurosurgeon BUT clinical signs may be a more *contiguous* and possibly *reliable* way to assess/follow pt with known or suspected bleed

Specifically, **pupillary assessment** is key

Key prognostic indicators

H. Bulstrode et al. / Injury, Int. J. Care Injured 48 (2017) 1098–1100

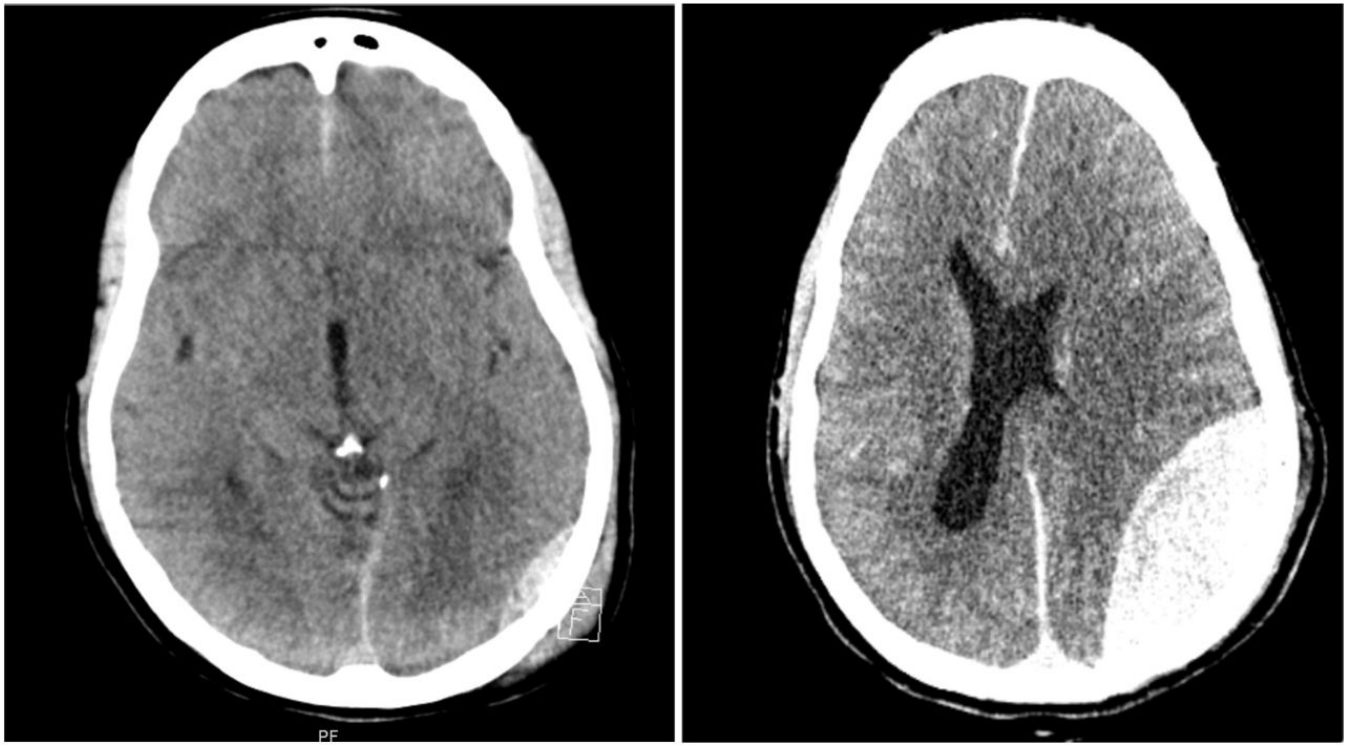
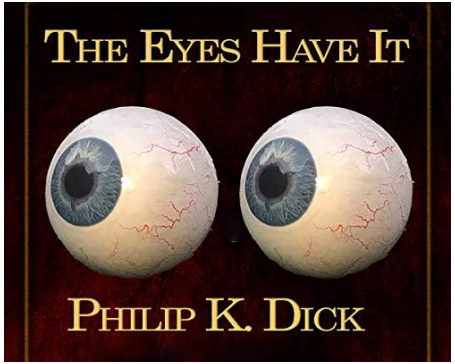


Fig. 1. Plain CT head example axial sections at admission (left) and one hour post admission, coincident with clinical deterioration (right).

Key prognostic indicators: the eyes have it



Time from *trauma* vs time from *anisocoria*: two key findings

-prospective case series of EDH pts with GCS <8 (Cohen et al, 1996)

-tracked time from first finding of a blown pupil to start of craniotomy (by neurosurgeon)

-the "anisocoria-craniotomy latency" (*you know*, the ACL)

-21 total patients, 14 with anisocoria (4 arrived with it, 10 developed it in ED)

-of the 7 who *never* had anisocoria, 1/7 died (15%)

-of the 14 with anisocoria, 6/14 died (**43%**); not statistically significant but still…

-**anisocoria*** is a bad sign **but** one we can continually reassess ***at the bedside*** even in obtunded and intubated patients

* new anisocoria/due to hematoma

Key prognostic indicators: anisocoria *is* bad--**but it's not too late!**

Patient	Age (years)/Sex	GCS Score	ACL (minutes)	GOS Score[a]
1	17/M	6	10	5
2	27/M	7	30	5
3	35/M	4	30	4
4	39/M	7	50	5
5	16/M	5	70	4
6	40/M	6	90	1
7	26/M	4	100	1
8	45/M	5	120	1
9	64/M	6	120	1
10	17/M	5	300	1
11	18/M	4	[b]	
12	30/M	7	[b]	
13	38/M	7	[b]	
14	56/M	6	[b]	

[a] 1, dead; 4, moderately disabled; 5, good recovery.
[b] Admitted to emergency room with anisocoria.

Table 1. Comatose patients with anisocoria.

Craniotomy **</= 70 minutes** of anisocoria: 5/5 lived
(with decent to very good outcomes)

Craniotomy **>/= 90 minutes** of anisocoria: 5/5 died

Not included in ACL analysis as these patients arrived with anisocoria--although several lived

Key prognostic indicators: *other* key signs

-GCS <8 (or depressed on arrival) without alternative explanation (eg ETOH)

-*worsening* mental status

-classical EDH pt who comes in talking and becomes obtunded or just worsening of GCS by >/=2

-hemiparesis (generally contralateral to side of trauma/known bleed)

-atypical pupillary abnormalities

-eg bilaterally fixed and dilated, contralateral fixed dilated

-Cushing's Triad: acute **hypertension**, **bradycardia**, irregular respirations

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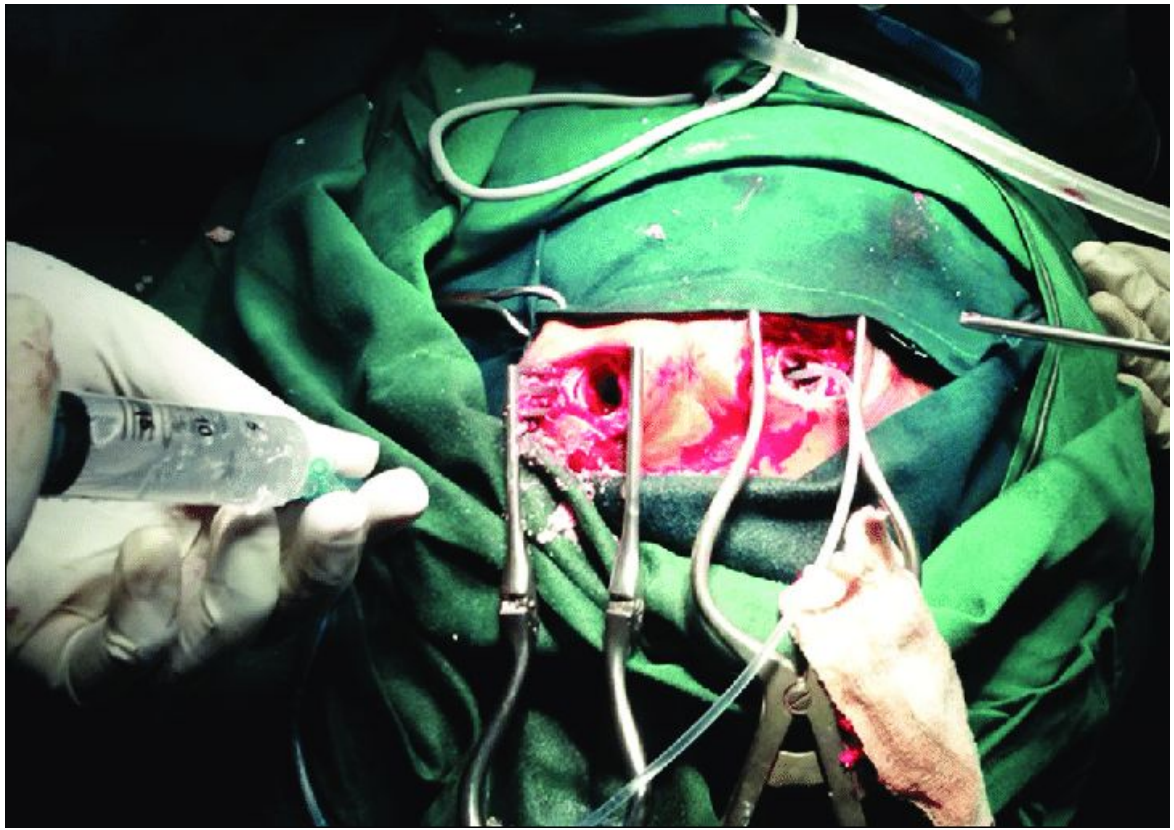
Should your site/providers be equipped and trained to do this?

A brief digression: can a little hole make a difference?



https://www.researchgate.net/figure/Irrigation-through-burr-hole-using-feeding-tube-in-the-treatment-of-chronic-subdural_fig1_301790364

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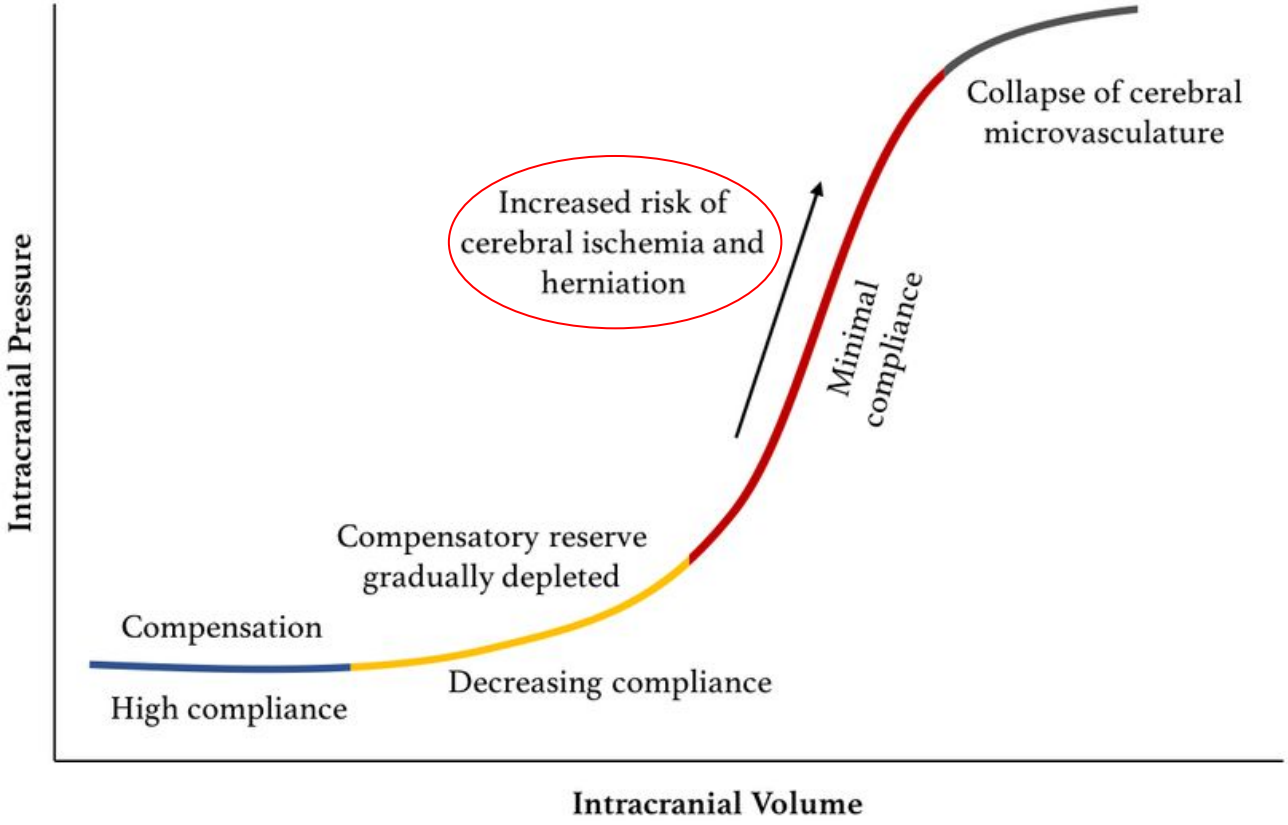

Harary, Maya & Dolmans, Rianne & Gormley, William. (2018). Intracranial Pressure Monitoring—Review and Avenues for Development. Sensors. 18. 465. 10.3390/s18020465.

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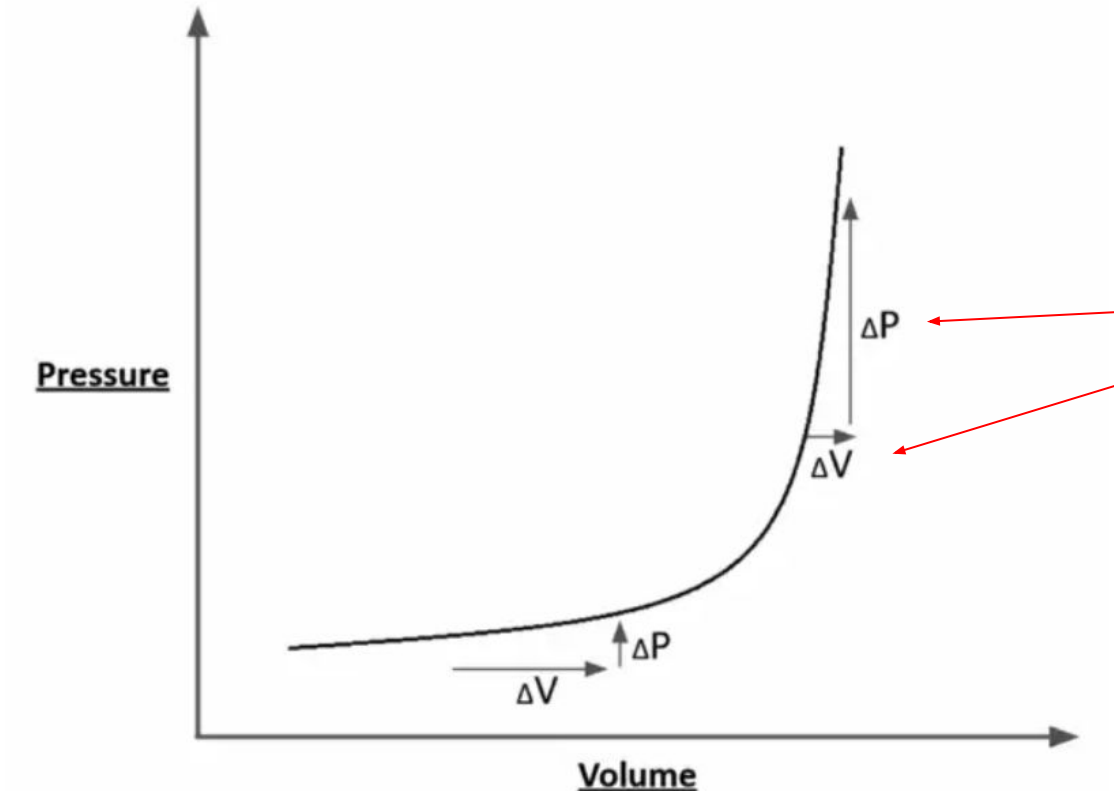

Yes!

via EMCrit: https://emcrit.org/ibcc/icp/

What's the evidence for non-neurosurgeon burr holes in EDH/SDH?

A 2020 meta-analysis of 6 sham-controlled RCTs found…

What's the evidence for non-neurosurgeon burr holes in EDH/SDH?

A 2020 meta-analysis of 6 sham-controlled RCTs found…

Ok, ok, there's not *no* evidence but it's not the best either

"Burr hole evacuation (trephination) *has been used* for acute EDH and *may be* lifesaving if access to neurosurgical expertise is limited or likely to be delayed.[28]" (emphasis added; McBride, EDH UTD)

What's the evidence for non-neurosurgeon burr holes in EDH/SDH?

Local Skull Trephination Before Transfer Is Associated With Favorable Outcomes in Cerebral Herniation from Epidural Hematoma

James A. Nelson, MD

Abstract

Objectives: The patient with epidural hematoma and cerebral herniation has a good prognosis with immediate drainage, but a poor prognosis with delay to decompression. Such patients who present to nonneurosurgical hospitals are commonly transferred without drainage to the nearest neurosurgical

Results: No evidence meeting methodologic criteria was found describing outcomes in patients transferred without decompressive procedures. For patients receiving local drainage before transfer, 100% had favorable outcomes.

Conclusions: Although the total number of patients is small and the population highly selected, the natural history of cerebral herniation from epidural hematoma and the best available evidence suggests that herniating patients have improved outcomes with drainage procedures before transport.

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ACADEMIC EMERGENCY MEDICINE 2011; 18:78–85 © 2011 by the Society for Academic Emergency Medicine

What's the evidence for non-neurosurgeon burr holes in EDH/SDH?

Patient Data From Included Articles on Nonneurosurgeon Skull Trephination or Burr Hole Drainage Before Transfer

Author, Patient	Diagnosis	Initial Exam	Exam Before Drainage	Pupil Exam	Exam After Drainage	ED Arrival to Decompression	CT to Decompression	Time to Craniotomy at Referral Center	GOS
Rinker, 1	EDH/SDH	5	3	Unilateral dilation	NA	63 min to OR	40 min to arrival in OR	NA	5
Rinker, 2	EDH	15	10	Unilateral dilation	NA	135 min to OR	50 min to arrival OR	NA	5
Rinker, 3	EDH	13	NA	Unilateral deviation	NA	90 min to OR	45 min to arrival OR	NA	5
Rinker, 4	EDH	8	8	Normal	NA	85 min to OR	45 min to arrival OR	NA	4
Rinker, 5	EDH	15	9	Unilateral dilation	NA	83 min to OR	35 min to arrival OR	NA	5
Rinker, 6	EDH	3	5	Unilateral dilation	NA	70 min to OR	35 min to arrival OR	NA	4
Smith, 1	EDH	Awake, talking, agitated. Soon intubated	NA	4 mm nonreactive	3 mm reactive	60 min	NA	180 min	5
Smith 2	EDH	alert, oriented	7 (then intubated)	dilated nonreactive	3mm, reactive	60 min	NA	180 min	4
Smith 3	EDH	15	7 (then intubated)	dilated, nonreactive	3mm reactive	NA	NA	NA	5
Smith 4	EDH	awake, alert, ambulatory	7 (then intubated)	dilated, nonreactive	reactive	60 min	NA	210	4
Smith 5	EDH	Reportedly returned to work	4, decerebrate	NA	NA	40 min	NA	120	5

Outcomes in the article by Smith et al. were originally reported in narrative style, but are easily translated to GOS for simplicity.
CT = computed tomography; EDH = epidural hematoma; GOS = Glasgow Outcome Scale; NA = not available; OR = operating room; SDH = subdural hematoma.

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Burr holes by general surgeons

Smith et al:
Burr holes by 2 EM docs, **3 FPs!**

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What's the evidence for non-neurosurgeon burr holes in EDH/SDH?

The old parachute problem…no RCTs prove they work!

*Retrospective case series and case reports support the use of burr holes in patients with **evidence of herniation** remote from definitive care*

Risks of burr hole placement are pretty reasonable/controllable:

- -infection
- -parenchymal brain injury
- -bleeding
- -lack of efficacy

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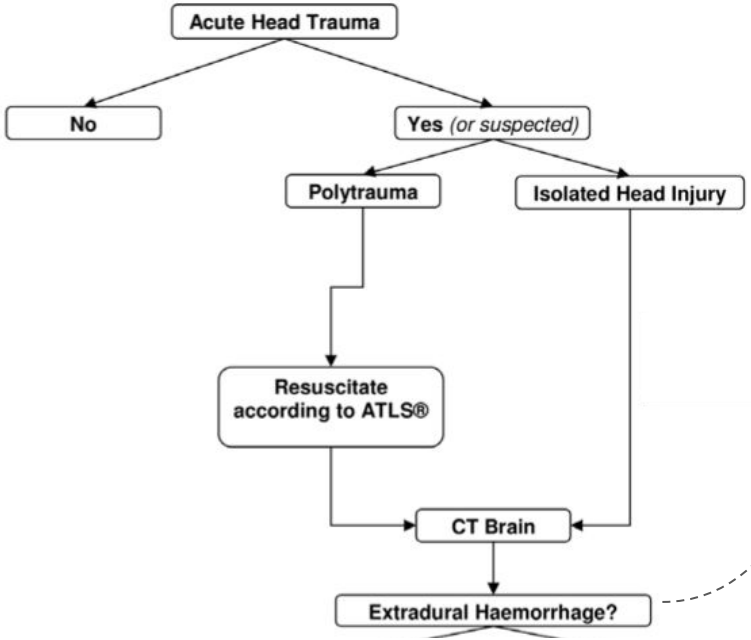
- -bleeding
- -lack of efficacy
- -lack of artistry*

What's the algorithm?



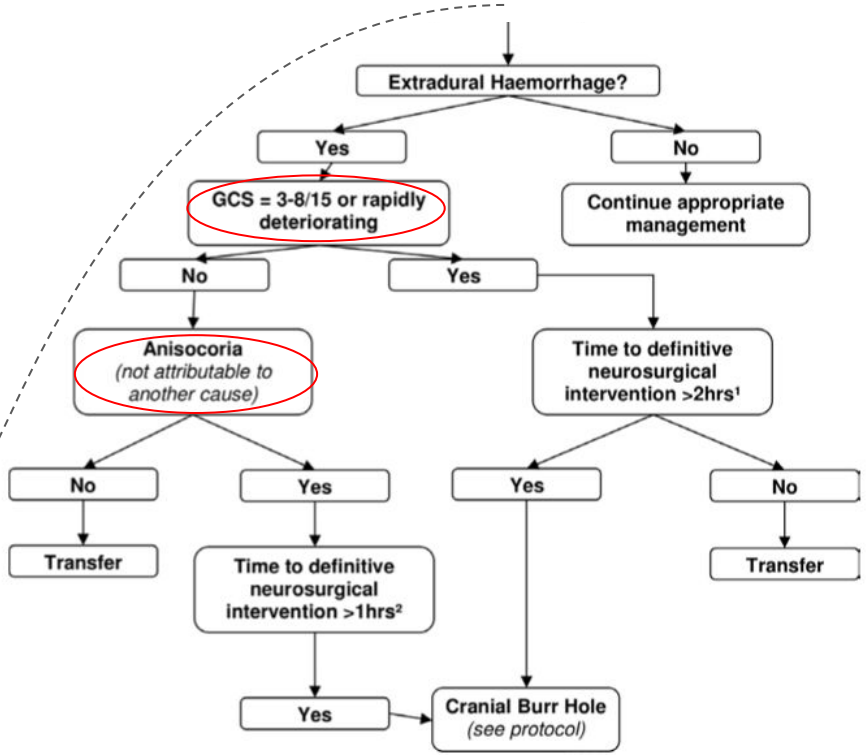


Figure 3 An algorithm to guide decision making in patients with extradural haemorrhage and delayed access to a neurosurgical facility. (1) Time from witnessed onset of coma (GCS 3–8/15), that is, 'talk-and-deteriorate' or from time of injury if comatose ab initio. (2) Time elapsed since anisocoria was first noted. GCS, Glasgow Coma Score.

(Howard et al.)

What's the evidence for non-neurosurgeon burr holes in EDH/**SDH**?

Management of acute traumatic intracranial haematoma in rural and remote areas of Australia

John Gilligan,* Peter Reilly,† Andrew Pearce‡§ and Danielle Taylor¶

*Health Advisory Committee, Royal Flying Doctor Service Central Operations, Adelaide, South Australia, Australia

†School of Medical Sciences, University of Adelaide, Adelaide, South Australia, Australia

Table 2 Nine rural craniotomy patients: principal head injuries, procedures and outcome

Age	Sex	Flight (km)	Cause	Alcohol	Diagnosis	NS	2y operation at RAH	Outcome (GOS) 9	ISS	Other injuries
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75	M	375	MVA		EDH	—	—	Good	16	
27	M	200	MVA/fall	Y	EDH	Y	Cranioplasty	Good	26	Fractured vault of skull
88	M	425	Fall		SDH (acute/chronic)	—	Repeat haematoma drainage	Good	N/A	
44	F	1250	Fall (horse)		SDH/EDH	—	Lobectomy, posterior fossa clot, VP shunt	Mod disabil.	N/A	Fractured base of skull
18	M	375	Fall (roof)	Y	SDH	—	—	Died	25	Multiple fractures of skull and facial bones
27	M	320	MVA		EDH	Y	Cranioplasty	Mod disabil.	26	Fractures of base of skull, malar and maxillary bones
78	M	1250	Fall	Y	SDH	N	Repeat haematoma drainage	Mod disabil.	25	Cerebral oedema
55	F	1250	MVA		EDH	N	Decompression cranioplasty	Mod disabil.	N/A	Cerebral oedema

EDH, extradural haematomas; ISS, Injury Severity Score; MVA, motor vehicle accident; SDH, subdural haematomas.

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9 burr holes (by surgeons) in 162 pts with EDH *or* SDH

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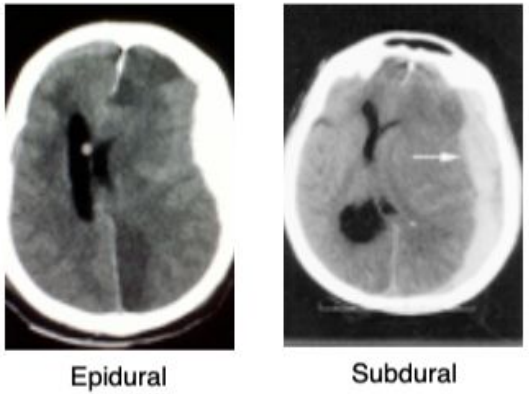
(Gilligan et al.)

What's the algorithm?

EMERGENT BURR HOLE in the ED
for decompression of Epidural or Subdural Hematoma

Indication
1. **GCS < 8**, and
2. **Epidural or Subdural** bleed with **midline shift** on CT*, and
   (*CT not necessary in crashing patient with high suspicion.)
3. **Unequal pupils**, and
4. Timely **Neurosurgical service NOT available**

"WAS AWAKE, NOW CRUMPING!"
Delay in decompression correlates with poor prognosis.



Epidural | Subdural

https://crashingpatient.com/wp-content/uploads/2014/09/burr-hole.pdf

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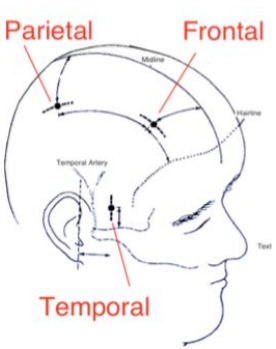
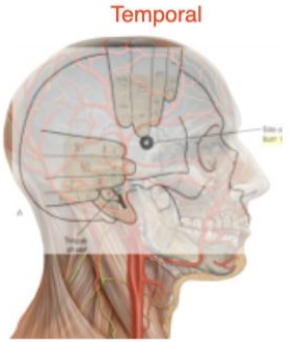
The basic procedure

Landmarks





Temporal: Two fingers up and two finger forward of Auditory Canal (just above zygomatic arch).

Frontal: 10 cm straight up from mid-pupillary line

Parietal: Over parietal eminence

Typically temporal (80%), but go to the middle of wherever the CT indicates the hematoma lies!
****If crashing, drill temporal lobe on SAME side as dilated pupil! If not better, then do other side.****

Equipment

1. Hair razor/ scissors
2. Scalpel
3. Retractor
4. Drill with drill-bit
5. Sharp hook
6. Suction tip
7. Dressing

Reference:
http://www.sjtrem.com/content/20/1/24

Tag Hopkins, MD - UC Davis 11/6/2012

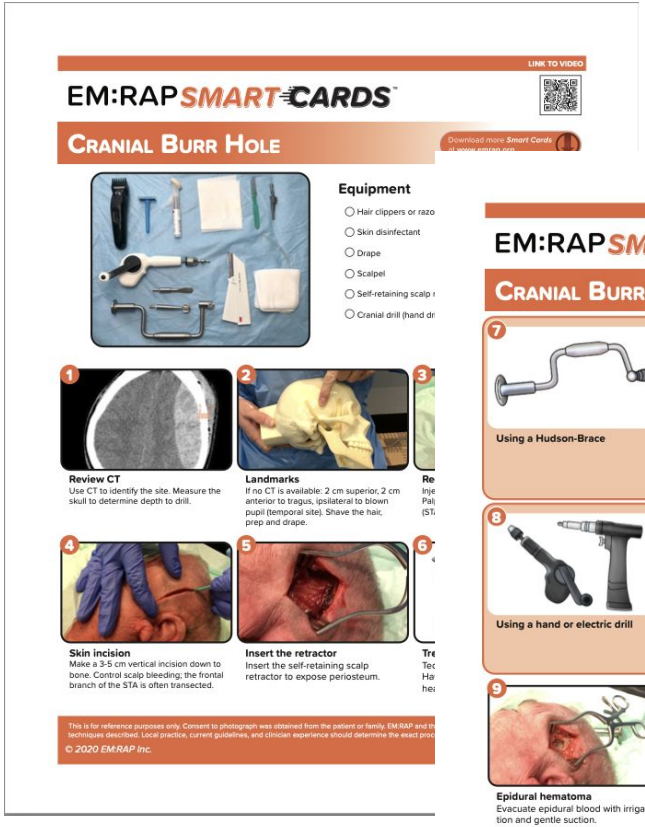
Procedure

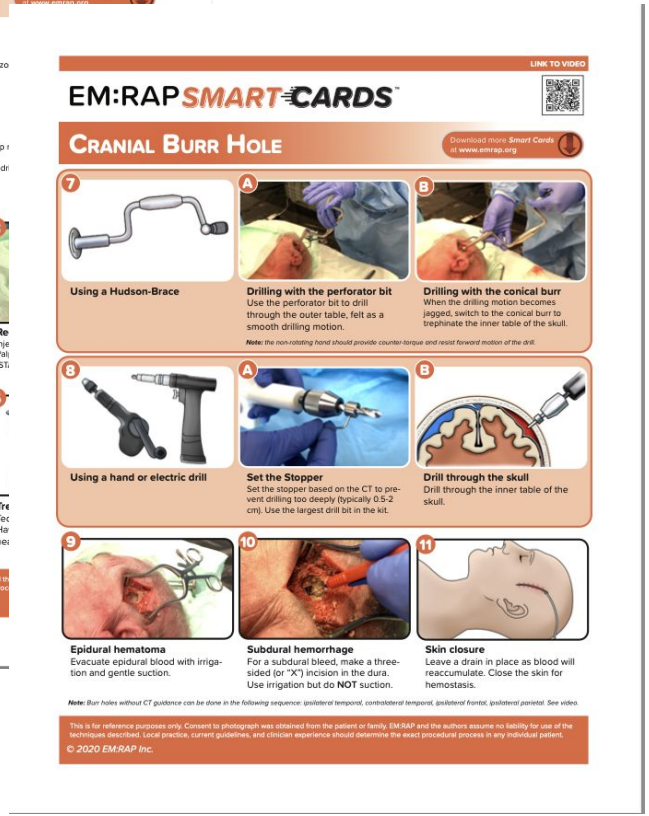
1. Find **Landmark.**
2. **Cut/shave hair** to make wide clear area.
3. **Clean** with betadine/cholrhexadine.
4. **Cut incision down to bone** (direct pressure on bleeding).
5. Use **retractor** to hold incision open.
6. Push or scrape **periosteum off bone** with knife handle.
6. **DRILL** perpendicular to bone (ideally apply saline drip/rinse). Will likely go through two layers/tables of bone.
7. **STOP once loss of resistance** (clutch mechanism may stop drill automatically).
8. Epidural **blood should evacuate.**
9. If subdural, very carefully **use hook or scapel on dura**.
10. **Carefully suction** if necessary, don't suction brain.
11. **Gently cover**, no pressure, with sterile dressing.
12. Give dose of **IV Ceftriaxone** time permitting.
13. DO NOT DELAY **IMMEDIATE TRANSFER**!

https://crashingpatient.com/wp-content/uploads/2014/09/burr-hole.pdf

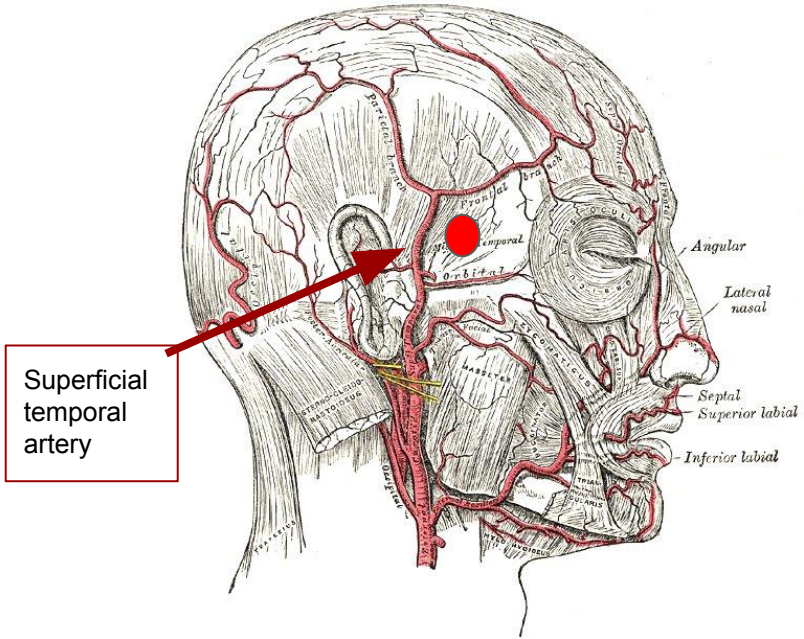
The basic procedure

https://youtu.be/QeDQZoeg0RA





Location, location, location



Case courtesy of Gray's Illustrations, Radiopaedia.org, rID: 36302

Figure 3 Diagram demonstrating position of standard burr holes (1, temporal (above zygoma), 2 frontal (over the coronal suture, approx 10 cm behind and in the mid-pupillary line) and 3 parietal (over the parietal eminence). CT Images

Oh, the places you'll burr! (Wilson, et al)

Learning objectives

Review basics of epidural and subdural hematomas

Discuss key prognostic indicators

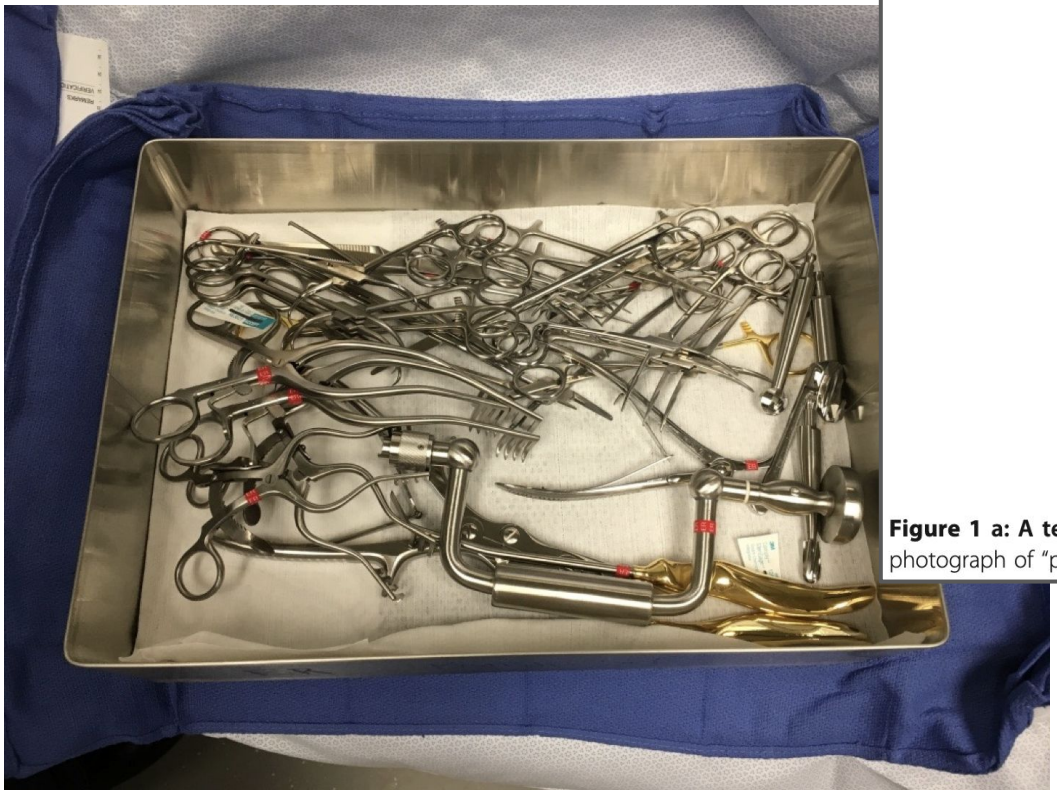
Discuss evidence for non-neurosurgeon burr holes

Review burr hole procedure

Review a burr hole alternative

Should your site/providers be equipped and trained to do this?

This is…a lot



Paul Charlton's PPT

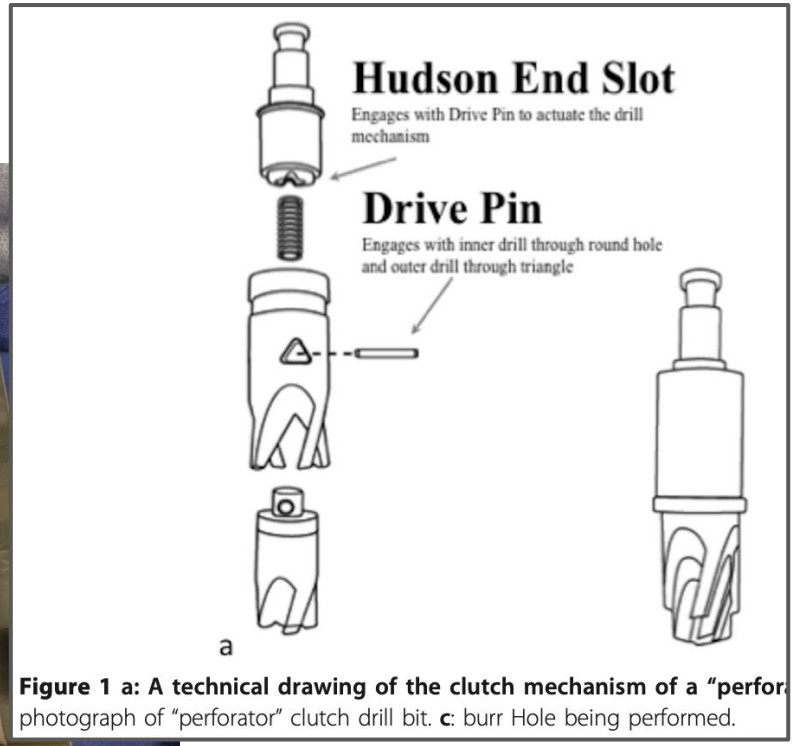


Figure 1 a: A technical drawing of the clutch mechanism of a "perfor
photograph of "perforator" clutch drill bit. **c**: burr Hole being performed.

Wilson et al.

EZ-IO?!?

Hello, friend

EZ-IO?!?

“We hypothesise that given our own recent experiences of evacuating extradural blood and thrombus through a 14 mm burrhole in the skull using irrigation and suction, **the lumen of an IO needle is almost certainly inadequate to shift sufficient thrombus.**”

Howard A, Krishnan V, Lane G, Caird J. **Cranial burr holes in the emergency department: to drill or not to drill?** Emerg Med J. 2020 Mar;37(3):151-153.

EZ-IO?!?

7 yo M, fell from bunk bed
-Initially drowsy then **obtunded**, R pupil **dilated**,
-CT: R EDH, e/o herniation
-IO placed per CT, 15ml blood returned but clotted
-craniotomy at tertiary center 6h after fall, 3.5h after IO
-made a full recovery, neurologically intact

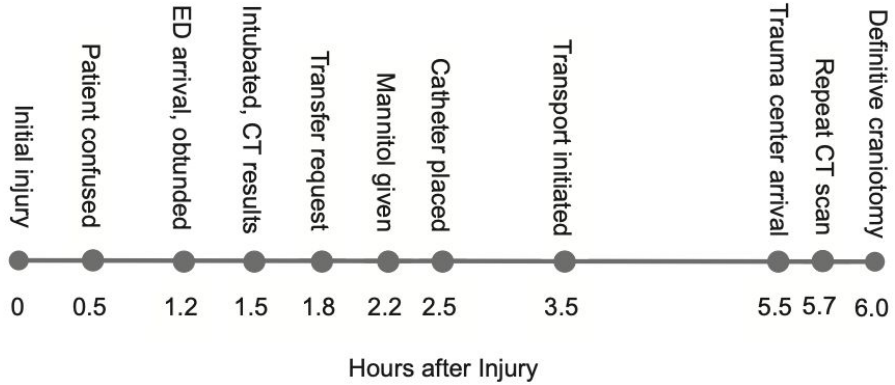


Figure 1. Timeline of events after initial injury.

Intracranial Intraosseous Catheter Placement to Temporize an Epidural Hematoma

William Weber, MD, MPH*; Teri Campbell, MSN; Thomas Papandria, MSN; Arjang Ahmadpour, MD
*Corresponding Author. E-mail: wweber@bidmc.harvard.edu.

Figure 2. External view of the intraosseous catheter connected to drainage with the hematoma withdrawn.

EZ-IO?!?

17 yo F, unrestrained passenger in MVA

-refused transport at scene then brief LOC and arrival via POV with friend; collapsed in ED, emesis

-PE: GCS 4, **L pupil blown**, L forehead hematoma

-CT: 1.5cm EDH with 7mm midline shift, no uncal herniation

-transport delayed by weather

-d/w peds NSG→ no burr hole stuff→EZ-IO→35mL blood out

-Pt "improved rapidly after the removal of blood and, while sedated and intubated, her GCS improved to 8"

-blood reaccumulated with repeat CT showing 8mm midline shift →transferred

-craniotomy→extubated day 1, d/c day 4 neurologically intact

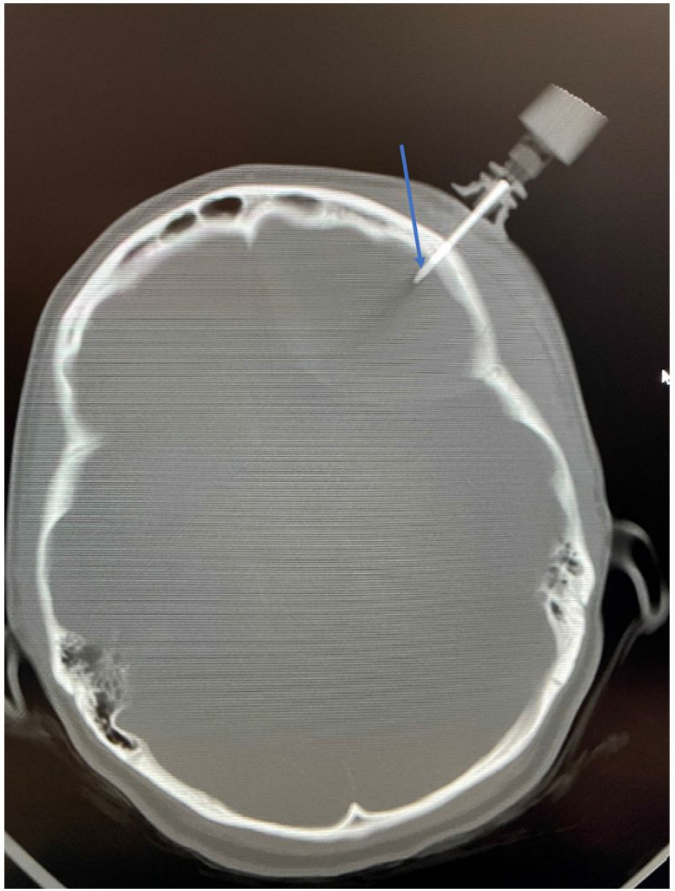


Figure 2. Computed tomography showing placement of emergent burr hole utilizing the EZ-IO® (arrow) into the left epidural hematoma.

EZ-IO?!? Remember this pt?

H. Bulstrode et al. / Injury, Int. J. Care Injured 48 (2017) 1098–1100

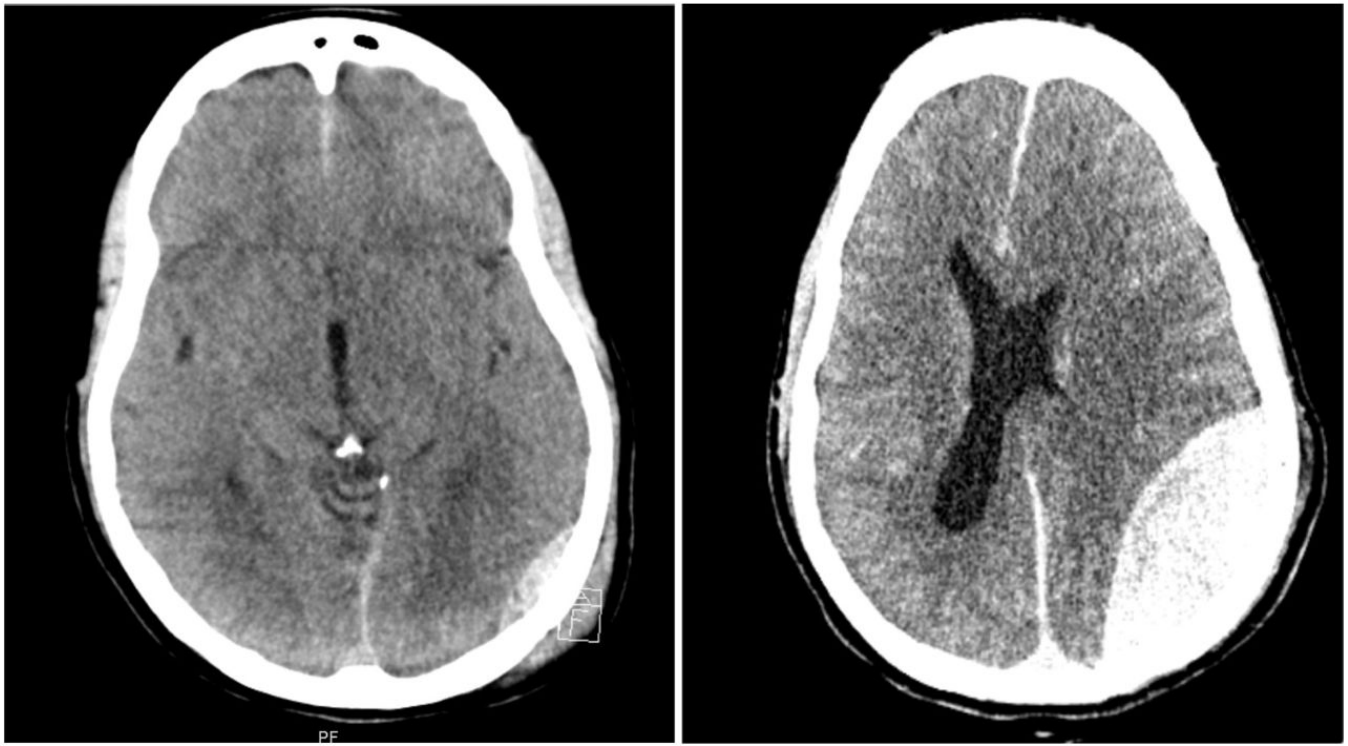


Fig. 1. Plain CT head example axial sections at admission (left) and one hour post admission, coincident with clinical deterioration (right).

EZ-IO *by a neurosurgeon*?!?

43 yo F pedestrian hit by car

-initial GCS 14 in local ED, initial CT showed small occipital EDH and repeat planned
-an hour later, vomited in scanner, GCS 8, L pupil blown
-airlifted to trauma center

"The patient arrived at the Wessex Neurological Centre…and proceeded directly to the Anaesthetic Room. During the Anaesthetic handover, an occipital site was shaved, prepared and incised, an IO needle track was drilled using a standard EZ-IO drill…. *30 ml of blood was aspirated immediately, and the procedure was completed within 8 min*."

-then proceeded to craniotomy (5.5h after injury); no residual neurological deficits

Fig. 2. Aspiration of extradural blood using intraosseous needle.

EZ-IO?!?

Decompression of Subdural Hematomas Using an Intraosseous Needle in the Emergency Department: A Case Series

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Ashkon Ansari, MD†‡

*LAC+USC Medical Center, Department of Emergency Medicine, Los Angeles, California
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‡Antelope Valley Hospital, Department of Emergency Medicine, Lancaster, California

62 yo M with *suspected* EDH coded on way to CT; after ~8 min ACLS:
-45ml EZ-IO inserted in temporal area with return of 10mL dark blood and ROSC→died

30 yo M with CT-demonstrated 16mm SDH developed acute bradycardia, HTN and GCS 13→4T
-worsened hematoma on repeat CT
-neurosurgeon on call was 30 min away and agreed with trying IO to temporize
-IO inserted at max depth of hematoma per CT
-15ml blood out and bradycardia resolved (but ultimately poor neuro outcome)

What's the algorithm?

Patient, injury, exam, CT, support

Favors caution

Favors action

Older and/or many comorbidities

Young, healthy at baseline

Polytrauma or poor prognosis generally

Isolated head trauma

Primary brain injuries

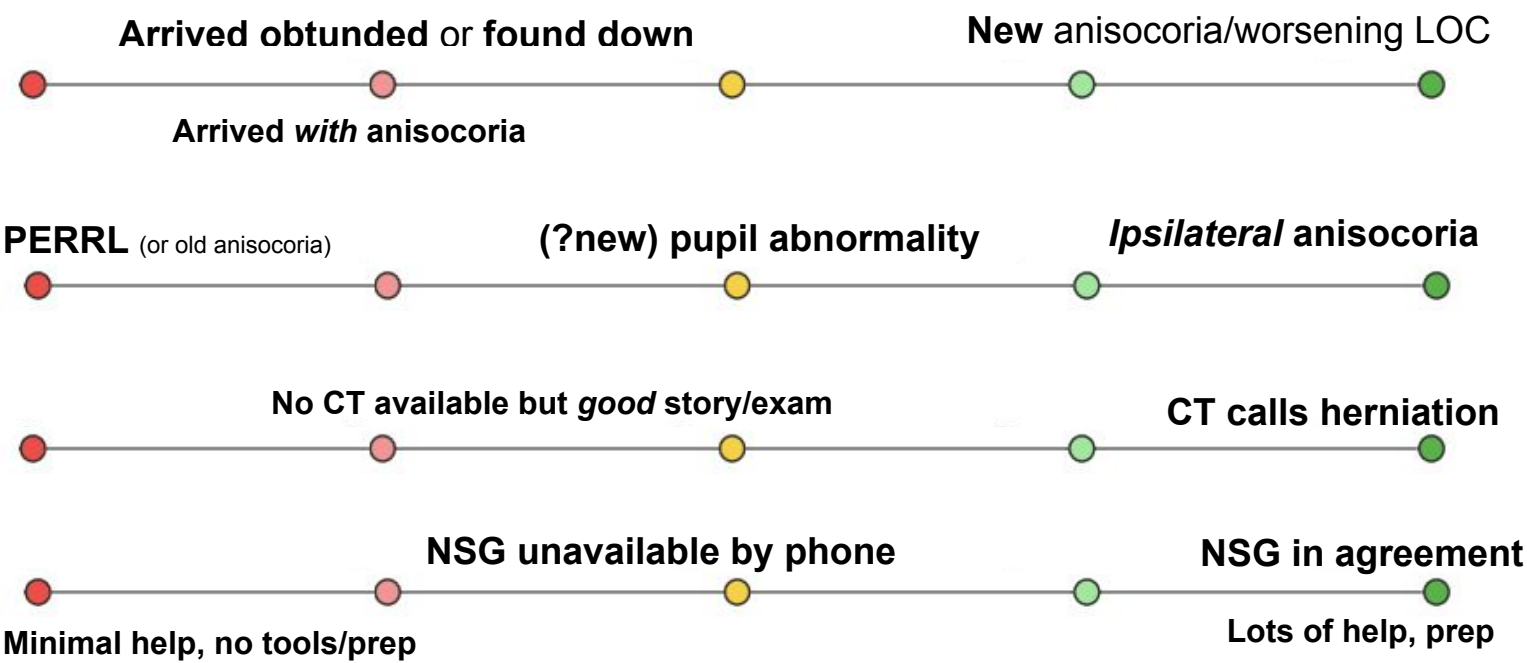
SDH

EDH

What's the algorithm? *Patient, injury, exam, CT, support*

Favors caution

Favors action



Aussie doctor uses household drill to save boy

A doctor in rural Australia used a household drill to bore a hole into the skull of a boy with a severe head injury, saving his life.

Relief: Nicholas with his parents Karen and Michael Rossi who can't praise Dr Carson enough for his quick-thinking actions

Learning objectives

Review basics of epidural and subdural hematomas

Discuss key prognostic indicators

Discuss evidence for non-neurosurgeon burr holes

Review burr hole procedure

Review EZ-IO alternative

Should your site/providers be equipped and trained to do this?

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