

SUBDURAL HEMATOMA



“David”, Marble, 1623 - 24. Gianlorenzo Bernini, Galleria Borghese, Rome.

Now the Philistines gathered their forces for war and assembled at Sokoh in Judah. They pitched camp at Ephes Dammim, between Sokoh and Azekah. Saul and the Israelites assembled and camped in the Valley of Elah and drew up their battle line to meet the Philistines. The Philistines occupied one hill and the Israelites another, with the valley between them. A champion named Goliath, who was from Gath, came out of the Philistine camp. His height was six cubits and a span. He had a bronze helmet on his head and wore a coat of scale armor of bronze weighing five thousand shekels on his legs he wore bronze greaves, and a bronze javelin was slung on his back. His spear shaft was like a weaver's rod, and its iron point weighed six hundred shekels. His shield bearer went ahead of him.

Goliath stood and shouted to the ranks of Israel... "Choose a man and have him come down to me. If he is able to fight and kill me, we will become your subjects; but if I overcome him and kill him, you will become our subjects and serve us." Then the Philistine said, "This day I defy the armies of Israel! Give me a man and let us fight each other." On hearing the Philistine's words, Saul and all the Israelites were dismayed and terrified.

Now David was the son of an Ephrathite named Jesse, who was from Bethlehem in Judah....

... David said to Saul, "Let no one lose heart on account of this Philistine; your servant will go and fight him."

Saul replied, "You are not able to go out against this Philistine and fight him; you are only a young man, and he has been a warrior from his youth."....

But David said to Saul, "Your servant has been keeping his father's sheep. When a lion or a bear came and carried off a sheep from the flock, I went after it, struck it and rescued the sheep from its mouth. When it turned on me, I seized it by its hair, struck it and killed it. Your servant has killed both the lion and the bear...."

Saul said to David, "Go then, and the Lord be with you."....

Then Saul dressed David in his own tunic. He put a coat of armor on him and a bronze helmet on his head. David fastened on his sword over the tunic and tried walking around, because he was not used to them.

"I cannot go in these," he said to Saul, "because I am not used to them." So he took them off. Then he took his staff in his hand, chose five smooth stones from the stream, put them in the pouch of his shepherd's bag and, with his sling in his hand, approached the Philistine

Meanwhile, the Philistine, with his shield bearer in front of him, kept coming closer to David. He looked David over and saw that he was little more than a boy, glowing with health and handsome, and he despised him. He said to David, "Am I a dog, that you come at me with sticks?" And the Philistine cursed David by his gods. "Come here," he said, "and I'll give your flesh to the birds and the wild animals!"

As the Philistine moved closer to attack him, David ran quickly toward the battle line to meet him. Reaching into his bag and taking out a stone, he slung it and struck the

Philistine on the forehead. The stone sank into his forehead, and he fell facedown on the ground.

So David triumphed over the Philistine with a sling and a stone; without a sword in his hand he struck down the Philistine and killed him.

1 Samuel 17-50

David's Bernini...borrowed some of its energy from Scipione's Gladiator, but for sheer whirling dynamic force left the classical sculpture in the dust. It was also, of course, in implicit competition with earlier versions, not just Michelangelo's, but also Donatello's lissom hero with the head of Goliath at his feet (1408-09), which, since he was the son of a Florentine sculptor, Bernini would certainly have known.

The difference of course is that Bernini's David is an all-action hero, caught just before the instant of the sling's release. (The rendering of that sling and the braided fibers of the rope are a tour de force of illusionist chiselling and drilling). Michelangelo's David seems to be gathering all his powers for the combat; Bernini's David is at the point of discharging it. The veins in his arm protrude through his skin with muscular effort. He pivots on the ball of his foot almost like a discus thrower, his left hand raised to apply more spinning force. But Bernini has achieved this effect without sacrificing the sense of intense mental concentration; body and mind in perfect synch. The face of Michelangelo's hero is impassively beautiful, but Bernini's works: brows furrowed jaws clenched, lips pursed. And those features are so precisely registered because, of course, they are Bernini's own, seen in a mirror held for him, according to Baldinucci, by Cardinal Maffeo Barberini.

The absorption of the maker in the subject is total - not just psychological, but physical too. Gianlorenzo, who prided himself on his athleticism, had practiced the slingshot (or something very like it) to get the look of the tensed and contracted muscles right. He has slain giants - Donatello and Michelangelo - and there is also a sense in his whiplash David, of conveying what the sculptor ought to be aiming for; not an elaborately and stately and studious craft, but - after proper planning, preliminary drawing and the creation of terracotta models - a furious liberation of instinctual animal motion.

And there was another feature of Bernini's performance as David that further revolutionized the genre. Because the sculpture discharges so much energy, it seems to generate the space into which it moves so that the force field of its impact keeps expanding - towards Goliath, towards us. As with Caravaggio, there's never a time when Bernini isn't conscious of the spectator, who becomes not just a silent starrer, but an actively engaged participant, moving around the piece and seeing it work in different ways from different perspectives (even when, as seems to be the case, its back was originally against the wall of the room). Centuries on, this understanding of sculpture as presenting not one but multiple images to us, each in a state of mutating motion as we move about it, might seem a truism; but in the 1620s it broke all previous conventions. Bernini discovered a way to make marble movies.

This gripping sense of continuous motion meant that Bernini - who as writer and presenter of plays must have thought about body language - could do stone drama like no one else. And the violent onrush of action, which in David just implies another

figure - Goliath - turns into actual collisions in the two great mythological pieces that made his fame: The Rape of Proserpine and Apollo and Daphne.

*Simon Schama, "Bernini, the Miracle Worker", in
"The Power of Art", 2006.*

Goliath, the giant Philistine, was the most feared warrior in all of Judah. Undefeated in battle, not one soldier from the armies of Israel (or anywhere else) dared to confront him in one on one combat. When the Philistines threatened Israel, a young boy named David stood forward and challenged the giant, much to his sarcastic amusement. Even though David was a just simple shepherd, he was not only the bravest man in all Judah, he was also unsurpassed in his skill with the sling. His powerful and astonishingly skilfully aimed shot struck Goliath fair square in forehead. Goliath instantly lost consciousness and fell face down onto the ground with a tremendous thud giving him a second severe head injury. The hubristic Goliath quite possibly succumbed to an acute severe subdural hematoma.



"11 Stones in a River", oil on canvas, hyperrealist, Johannes Wessmark

"...Then he took his staff in his hand, chose five smooth stones from the stream, and put them into the pouch of his shepherd's bag...."

I Samuel

SUBDURAL HEMATOMA

Introduction

Subdural hematomas are due to a collection of blood accumulating between the dura and the arachnoid.

They can be acute, subacute or chronic.

The need for treatment and its urgency will depend on a range of factors, including in particular the neurological status of the patient and the age of the bleed.

Treatment may range from urgent to conservative depending on these and other factors.

Pathology

Subdural hematomas are due to a collection of blood accumulating between the dura and the arachnoid.

They are relatively more common than extradural hematomas, and constitute about 30% of severe brain injuries. ¹

Subdural hematomas are usually secondary to tearing of bridging veins that run between the cortex and the dural venous sinuses.

Acute subdural hemorrhage carries a high untreated mortality similar to acute extradural hemorrhage. ³

Risk factors:

Risk factors for *subdural hematomas* include:

- Cerebral atrophy
- The elderly
 - ♥ Younger patients usually require a moderately forceful injury, but the elderly may suffer a subdural hematoma from relatively minor trauma.
- Neonates, young children
 - ♥ These age groups may suffer a subdural hematoma from a shaking (abuse) injury.
- Alcoholics
- Patients with coagulopathies, including those on warfarin or a NOAC

Clinical Features

Important features on history include:

1. The mechanism of injury:
 - There may be a history trauma followed by loss of consciousness, though loss of consciousness is variable.
 - Note however that **subacute** or **chronic** subdurals are not uncommonly found in the elderly and confused and where no clear history of trauma may be available.
 - The subdural hematoma in these cases is often found on CT done for investigation of a non-specific alteration in conscious state or confusion.
2. Persistent significant headache.
3. **Persistent vomiting.**
4. How has the patient's neurological status changed since the injury?
5. Any co-morbidities.
5. The usual level of function in cases of debilitated patients, such as nursing home patient in particular.
6. Is the patient on **warfarin or a NOAC?**

Important features on examination include:

1. The immediate priority will be the assessment of ABC issues.
2. Conscious state, including the GCS.
3. Does the patients have localizing neurological signs?
 - Unilateral limb weakness
 - Pupil size and reactivity

It is vital to appreciate however that classic "localizing signs" are rarely present and occur **late if at all**.

Headache and persistent vomiting as well as more minor degrees in alteration of conscious state constitute far more common presentations.

Note also that so called "localizing signs," do **not** always accurately reflect the side of pathology.

4. Look for any other significant injuries, especially to the cervical spine.

Investigations

Blood tests:

- FBE
- U&Es and glucose
- Clotting profile, (always check if the patient is on warfarin)

Others as clinically indicated.

EKG

- Non-specific ST changes
- Arrhythmias

Bradyarrhythmias may be seen if the patient has significantly raised intracranial pressure.

CT scan brain:

This must be done on an urgent basis for any patient who may have an extradural or subdural hematoma.

Note that some patients may be drug or alcohol affected and so are difficult or impossible to assess neurologically and the threshold for CT scan must therefore be low in these cases.

Patients who are on warfarin or a NOAC and have sustained a head injury should have a very high index of suspicion for intracranial haemorrhage; no matter what neurological signs they may or may not have.

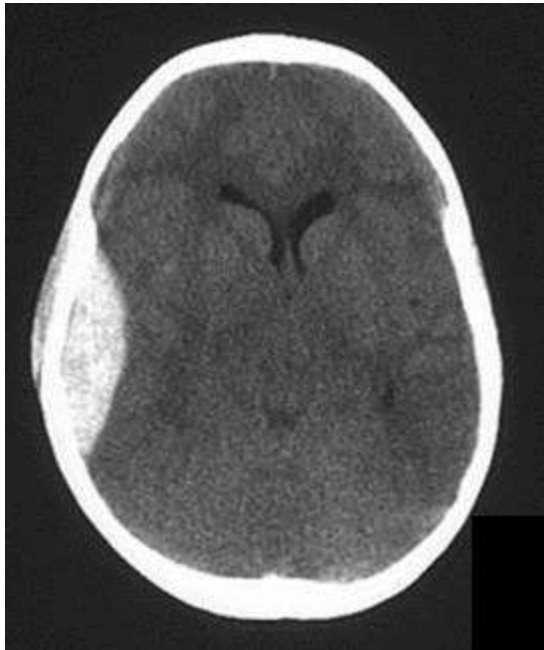
Characteristics of subdural hematomas include:

- Elongated concave shapes, conforming to the contours of the brain (as shown below right).
- They do not cross the midline because of the meningeal reflections, (unlike extradural hematomas).

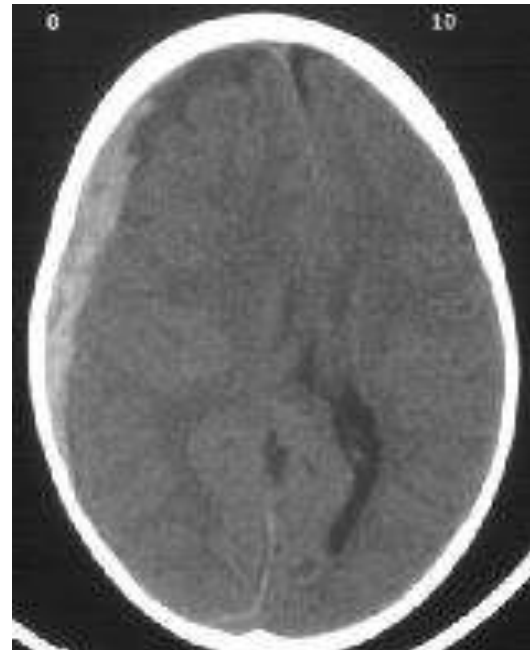
If seen on either side of the midline, this represents **bilateral** subdural hematomas.

- They can cross suture lines as they are not restricted by dural tethering at the cranial sutures, (in contrast to extradural hematomas)

- They can also occasionally track along the **falx** or **tentorium**, (See Appendix 1 below).



CT scan of extradural hematoma



CT scan of subdural hematoma

Extradural hematomas typically have a biconvex or lens shape, (as shown above left). This is in contrast to subdural hematomas, which typically have a more elongated concave shape, conforming to the contours of the brain (as shown above right).

It is important to look for any associated signs of raised intra-cranial pressure.

These signs include:

- Midline shift
- Loss of sulci
- Loss or deviation of intracerebral ventricles
- Loss of the basal cisterns.

Radiologically, subdural hematomas may be roughly classified as: ²

Acute:

- < 24 hours old
- These show as hyperdense collections, as compared to adjacent brain tissue.

Subacute:

- About 2 weeks old

- These show as isodense collections as compared to adjacent brain tissue, (and hence may be difficult to distinguish)

Chronic:

- Greater than 2 weeks old.
- These show hypodense collections as compared to adjacent brain tissue.

Mixed:

- Note that in cases of repeated trauma acute subdural hematomas, may be seen superimposed on a subacute or chronic hematoma
- High attenuation acute bleeds will tend to layer out inferiorly (in a supine) patient, and will contrast with the low attenuation blood of a chronic collection which will be seen superiorly.

See Appendix 2 below.

MRI

This can also readily diagnose subdural hematoma, but is not usually necessary with the availability of a CT scan.

It is useful in the following cases:

- If there is a contraindication to CT scan, (radiation avoidance) and the case is non-urgent.
- Isodense hematomas, difficult or impossible to distinguish on CT
- Non availability of CT
- Delineation of further intracerebral pathology, eg venous thrombosis

MRI is problematic in cases where patients are unstable and/ or cannot cooperate with the imaging procedure. Expense and availability are also limiting factors in its use.

Management

1. ABC:
 - The immediate priority is to assess and secure any ABC issues and establish IV access in all cases.
2. Cervical spine precautions as clinically indicated.
3. Monitoring:

- There should be ongoing ECG and pulse oximetry monitoring.
4. Analgesia:
- Give adequate analgesia and antiemetic as indicated.
5. Correct coagulopathies:
- If a patient is on warfarin, this must be reversed with prothrombin X, FFP and vitamin K.
6. IV mannitol:
- May be given as a temporizing measure prior to the operating theatre, if there are signs of severely raised intracranial pressure such as rapidly deteriorating conscious state and/or a falling pulse rate in association with a rising blood pressure.
 - Give 0.5 - 1.0 grams/kg IV
7. Prevent secondary brain injury:
- Especially in the case of intubated patients:
- Head up 30 degrees.
 - ♥ This will moderately reduce ICP without compromising cerebral perfusion pressure.
 - Avoid hypoxia and maximize oxygen delivery
 - Maintain **normocarbica**, (avoid hypercarbia or hypocarbica).
 - Avoid acidosis
 - Avoid hypotension (SP < 90 mmHg).
 - Avoid hyperthermia
 - Avoid hyperglycemia or hypoglycemia.
 - Avoid seizure activity.
8. Anticonvulsants: ¹

These should be given in acute injury.

3 factors have been identified in the development late epilepsy in severe head injuries:

- Seizures occurring within the first week.

- An intracranial hematoma.
- A depressed skull fracture.

Prophylactic phenytoin will reduce the incidence of seizures in the first week post injury, but not thereafter.

In adults give:

Phenytoin 1 gram IV at a rate not faster than 50 mg / min.

9. Antibiotics:

- These are given for cases of compound skull fractures.

10.. Steroids: ¹

- Steroids do **not** have any beneficial effect on controlling raised intracranial pressure in severe head injury, nor have they shown any benefit in outcomes.
- Some studies in fact have demonstrated **worse outcomes** with steroid use.
- Steroids therefore are **not recommended** in the management of acute brain injuries.

Disposition:

There should be timely consultation with the neurosurgical unit as soon as the diagnosis has been established and the patient stabilized.

The neurosurgeon will especially need to know the following:

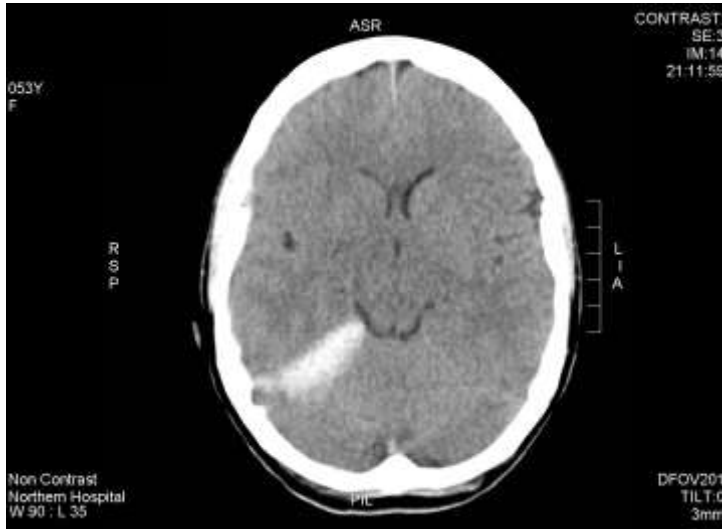
- The radiological diagnosis, including any signs of raised intracranial pressure.
- The likely acuity of the bleed.
- The patient's current neurological status, including:
 - ♥ The GCS
 - ♥ Whether there are any localizing signs
 - ♥ Any changes that have occurred in this status since the injury.
- The presence of any associated injuries.
- Any significant co-morbidity, including especially in the case of elderly and debilitated patients, their normal functional status.

The neurosurgeon will make a decision about the need for and urgency of surgical drainage.

Factors that will influence the decision to operate in cases of subdural hematoma will include:

- The age of the subdural bleed, (acute, subacute, chronic)
- The extent of the subdural bleed, including the degree of raised intracranial pressure demonstrated on CT scan
- The neurological status of the patient.
- The extent of associated traumatic injury, if any
- The comorbidity profile of the patient
- The age and normal functional status of the patient
- The quality of life of the patient
- The presence and type of any pre-existing limitation of medical treatment plan.
- The wishes of the family

Appendix 1



The uncommon supratentorial (in the sense of lying directly on top of the tentorium) appearance of a subdural hematoma. Here the hematoma does not have the typical concave appearance, as it is tracking over and along the tentorium over the floor of the posterior cranial fossa - as opposed to along the cranial vault. This was a subdural hematoma sustained in a 53 year old woman who had fallen from a horse.

Appendix 2



Cerebral CT scan of a 77 year old male, who presented with recurrent falls and increasing confusion. The CT shows left sided subdurals of variable ages. The hyperdense regions represent acute bleeding, the dark hypodense region superiorly represents a chronic bleed, while the large isodense region inferiorly represents a subacute bleed (approximately two weeks old). There is significant mass effect, with midline shift to the right, total loss of sulci on the left, and total obliteration of the left ventricular system. Note the relative difficulty in detection of the isodense hematoma. Bilateral isodense hematomas may not show midline shift, and may be very difficult to diagnose on CT scan.

References

1. ATLS Manual 8th ed 2008
2. Rosen P et al. Diagnostic Radiology in Emergency Medicine, Mosby 1992
3. G. O'Reilly et al. Neurotrauma in Textbook of Adult Emergency Medicine, Cameron et al Churchill Livingstone 4th ed 2015.

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Reviewed March 2015