Lateral Craniotomy

Pitman Mbabazi and Benjamin Mutiso

Introduction:

Trauma is a commonly encountered pathology by a surgeon and traumatic head injury bears a significant burden with detrimental outcome if timely diagnosis and care is not executed.

Intra cranial hematomas (acute epidural and subdural hematomas) are not uncommon in a set up of trauma, and more often than not will need emergency surgical evacuation.

Epidural hematomas are commonly due to high impact injury to the head with an underlying fracture of the temporal bone and laceration of the middle meningeal artery, leading to hemorrhage into the epidural space, while subdural hematomas are often to shearing of the bridging vessels, or even the surface cortical brain vasculature, hence bleeding into the subdural space. The accumulating hematoma causes a pressure effect on the brain and subsequently can lead to irreversible brain injury or even herniation if not attended to.

This chapter covers an approach to the surgical management of both intra cranial hematomas, which usually require an emergent evacuation through a craniotomy and a temporoparietal (lateral) craniotomy is handy for evacuation of most of these collections.

Lateral craniotomy for intracranial hematoma or abscess proceeds in the following steps:

- First step
- Second step
- Third step

Steps:

The following equipment is needed:

Head ring (Doughnut head rest) and shoulder roll.
Diathermy, monopolar and bipolar
Bone wax
Oxycellulose (Surgicel®) or absorbable gelatin (Gelfoam®) (if available)
Hudson Brace and appropriate perforators
Functional suction machine
For craniotomy, either of these:

- Power Drill (Such as Midas Rex® by Medtronic)
- Gigli saw and saw blade passer (Such as Poppen saw guide)

1. General anesthesia is required for this operation, especially in moribund patients the airway must be controlled (see Airway Management and Endotracheal Intubation.)
2. The arms are at the patient's side. The head is rotated away from the side of injury and held in place with a head ring (see Supine Position.) The head of the bed is elevated to decrease venous pressure and blood loss.
   - If a large cerebral sinus is entered during the operation, place the patient horizontal again to decrease the chances of air aspiration into the vein and embolization.
3. In cases of acute trauma, cervical spine injury precautions must be adhered to until a cervical spine injury has been ruled out. Rather than rotating the head, the entire patient is rotated 30 degrees away from the site of injury, either by rotating the bed or by placing rolled sheets under the patient's shoulders, torso, hips and legs.
4. A urinary catheter is advised to aid peri-operative monitoring, if there is no sign of urethral injury (see Approach to Lower Genitourinary Tract Injuries.)
5. The ipsilateral half of the scalp hair is clipped and the field washed and prepped. We use soap and water then later preps with chlorhexidine (avoid contact with the eyes) or betadine solution depending on availability.
6. A "question mark" incision is marked on the ipsilateral side, based on the following landmarks:
   - 1cm anterior to the tragus, keenly palpate for the superficial temporal artery pulse, and mark posterior to it. Avoid injury to this artery because it's a major pedicle that supplies the created scalp flap.
   - The mark is taken posterior and superior to the ear lobe (0.5cm from the pinna) and 2-3cm posterior to the ear and curved anteriorly 2-3cm lateral to the midline. Anterior extension is relative to the location of the target lesion and the hairline should not be crossed if possible.
7. The incision site is infiltrated with local anesthetic agent with epinephrine (1-0.5%

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lidocaine with epinephrine 1:100,000). This helps to minimize bleeding as well as enhance peri-operative pain management.

The planned incision site is infiltrated with local anesthetic with epinephrine. Doing this ½ hour or more before the incision makes hemostasis more effective than if it is done immediately before the incision.

8. The surgical site is draped, with a midline drape (as a guide to the location of the sagittal sinus) and anterior drape at the hairline. Experienced neurosurgeons will not include the ear in the field, but the "amateur" is encouraged to include at least part of it to help with orientation.

Planned curvilinear incision extending superiorly posterior to the ear lobe and then parallel but medial to the sagittal sinus. The superficial temporal artery, which will provide the flap's blood supply, is usually palpable in the area shown by the Red dot. Take care to not cut or use excessive diathermy in this area.

9. An incision is made along the marked area with a knife through the skin and dermis and then with mono-polar diathermy down to the bone. Cauterize any bleeding scalp vessels and go slowly by layers. Pressure on either side of the incision is applied by both the surgeon (using the non dominant hand) and assistant to minimize blood loss during incision.

The surgeon applies pressure to one side of the incision as it proceeds, while the assistant applies pressure to the other side and suctions within the wound, to control bleeding and prevent excessive blood loss from the scalp.

10. Carry the incision all the way down to and through the pericranium.

Once the incision through the scalp is made, the incision is continued down to the pericranium.

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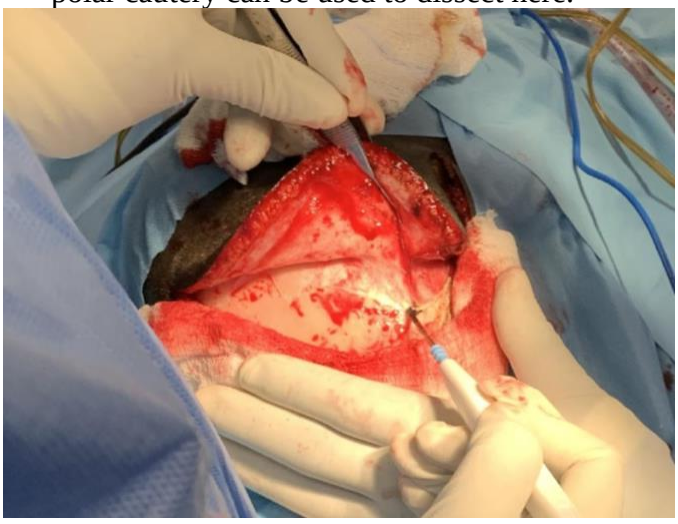
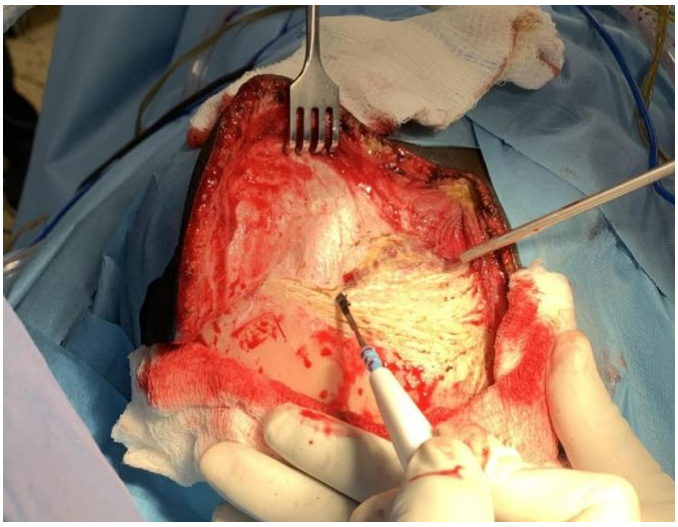
11. A periosteal elevator is used to raise the periosteum in bulk with the scalp layers of the bone from the incision. Use bone wax or the monopolar diathermy to control any bleeding from the skull itself.

All of the flap, including all layers of the scalp, the periosteum, and eventually the temporalis muscle, are elevated together.

12. The temporal muscle is raised in bulk with the scalp. At this point the dissection becomes more difficult as the tissue is more firmly adherent to the skull. To minimize the bleeding, a mono-polar cautery can be used to dissect here.

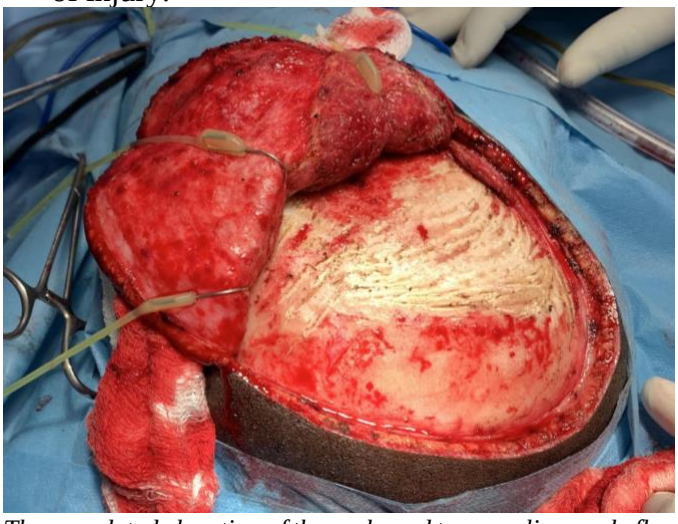


The tip of the diathermy shows where the temporalis muscle begins. It is easy to get in the wrong plane here and continue to elevate the scalp off the temporalis muscle.



Elevating the temporalis muscle off of the skull is more difficult than elevating the periosteum alone. The diathermy is helpful here.

13. Continue to elevate the flap all the way to the level of the zygomatic arch inferiorly and the forehead anteriorly. If your dissection extends far anteriorly, take care not to injure the supraorbital and supra trochlear nerves. As the scalp is elevated, often in an epidural hematoma, an underlying fracture line is noted- most commonly involving the temporal bone. However, this can vary and may extend or involve any bone depending on the mechanism of injury.



The completed elevation of the scalp and temporalis muscle flap exposes a wide amount of the lateral skull. Elastic retraction hooks are being used here.

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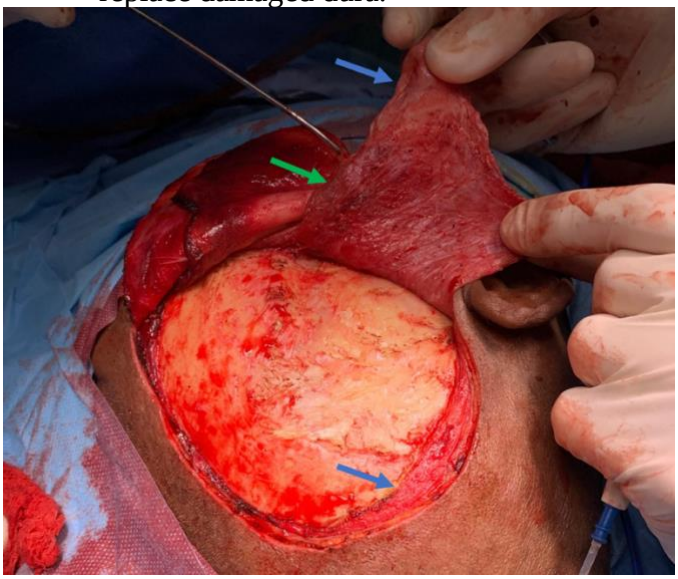
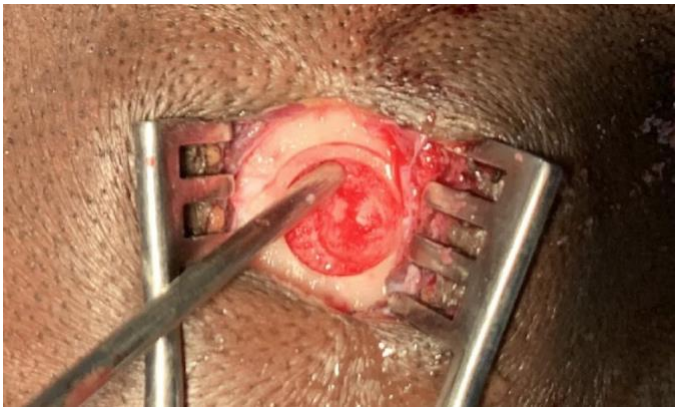
14. Alternatively, if you anticipate difficulty in closing the dura, as with a depressed and comminuted skull fracture, elevate the scalp and temporalis muscle in two layers. This takes longer so it should not be done in a patient who is decompensating acutely. Proceed in the following manner:
    - Without incising the pericranium, elevate the scalp off the temporalis muscle to its full extent
    - Incise the pericranium just above the temporalis muscle and elevate the temporalis muscle to the level of the zygomatic arch as described above.
    - Incise and elevate the pericranium separately, preserving a large piece to use as a patch to replace damaged dura.



In this photograph, the temporalis muscle (Green arrow) and pericranium (Blue arrows) have been elevated. If the incision is made just along the edge of the temporalis muscle, this leaves a large swathe of pericranium to be harvested intact and used as a patch in case of dura loss due to skull fracture.

15. With the bone exposed, sites of burr holes are marked out and using a Hudson brace the burr holes are made. Available are the self-locking and non-locking perforators. The former automatically stop drilling and do not advance beyond the inner table of the skull while the latter do not, hence can plunge into the brain.
    - We prefer to make 3 to 4 burr holes at the pterion, posterior frontal bone, inferior and superior temporal bone. However these are guided by the location of the hematoma. Subdural hematomas and empyemas generally require larger sized craniotomies (at least 8 by 10cm).
    - While drilling the burr holes, saline irrigation is done onto the site to reduce the amount of heat generated and subsequent necrosis.
    - A smooth dissector (number 9) is used to dissect the dura off the inner table, circumferentially in all the burr holes.

A non-locking perforator for the Hudson Brace. The surgeon should proceed carefully and stop when the tip reaches the inner table (shown by the Red line) before the entire perforator passes through the skull.



Proper technique for making a burr hole, shown from a simple burrhole operation. The principles are the same for burrhole made during craniotomy. At the base of the cranial incision, only the tip of the bone has been breached. The surgeon stops before the entire perforator goes through the bone.

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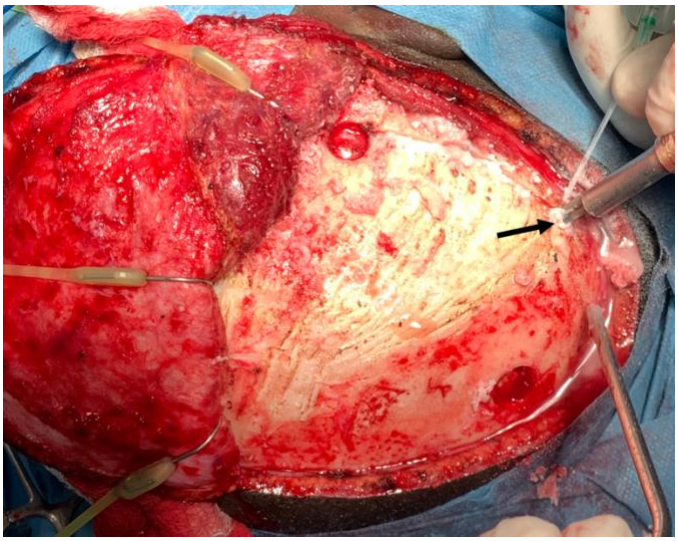
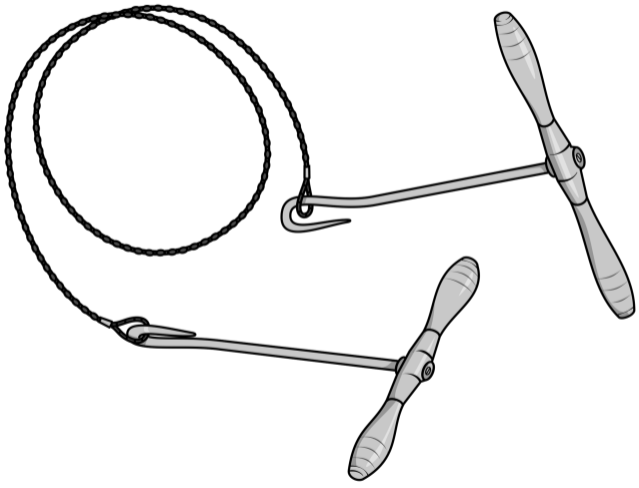
The side-biting (Kerrison) rongeur is used to widen the burr hole to its full size, as shown here in a simple burrhole craniostomy operation.

16. The bone flap can be raised at this point: Using a power drill (Medtronic Midas Rex®) or a Gigli saw.
    - The power drill cutter is introduced in one of the burr holes and used to connect to the subsequent holes. If you have incised the dura already, ensure that the "foot" of the saw does not go through the dura, only cut the bone at this time.
    - Connect the inferior burr holes last due to the increased risk of injury to the middle meningeal artery. Also, a dural tear is more likely at this location.
    - Cold saline irrigation is used during this process to reduce the heat generated while cutting the bone.



The power drill is equipped with a rotating blade and a foot. This is engaged and used to cut the bone proceeding from one burr hole to another. It is important to continuously irrigate while using the electrical drill, because excessive heat can damage bone and impair healing.

17. Alternatively, with a gigli saw: a saw introducer (Poppen saw guide) is used to pass the saw across two burr holes. Alternatively the saw blade can be bent so it curves upwards and then passed by itself from one burr hole to the other.
    - The incision between the holes is cut in a slanting manner to ease re-placement of the bone flap.
    - The same is done to connect all the holes and subsequently fully elevated the flap.



Gigli Saw: Cutting wire can be detached from the handles and passed between two burrholes. Alternatively, Kocher clamps can be used to grasp each end of the saw blade. Source: Olek

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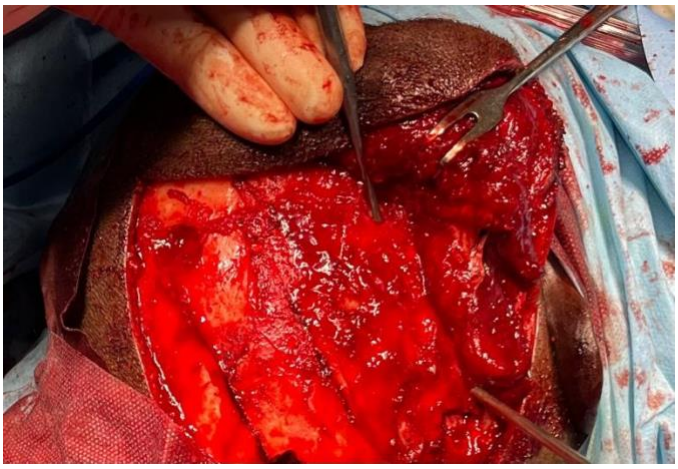
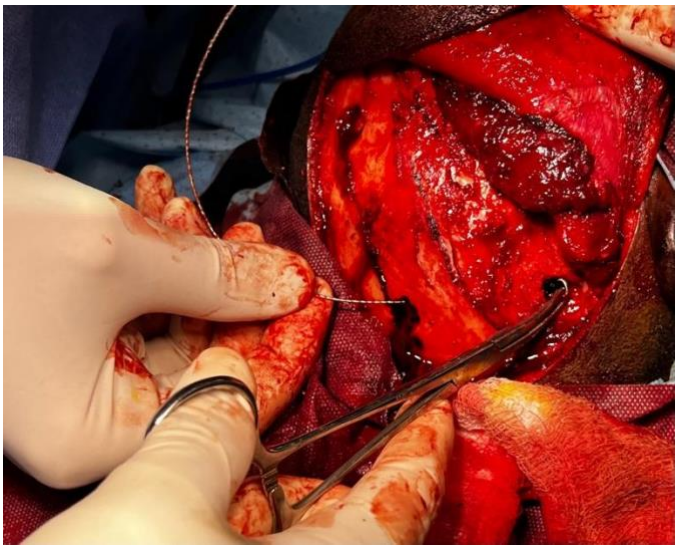
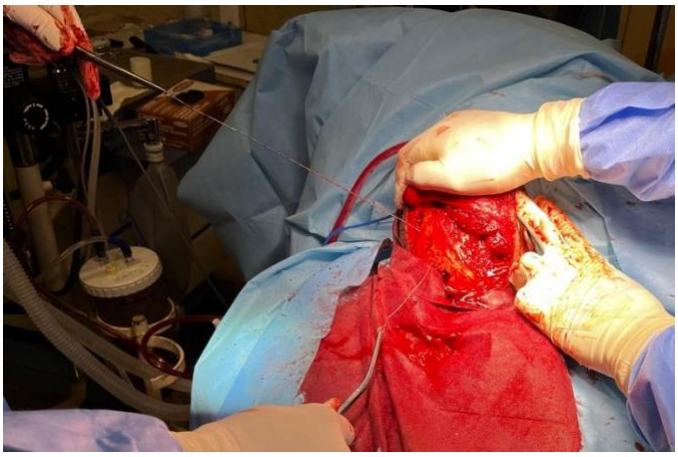


Using a fine periosteal elevator (Penfield,) separate the dura from the bone adjacent to each burr hole before attempting to pass the wire saw blade.

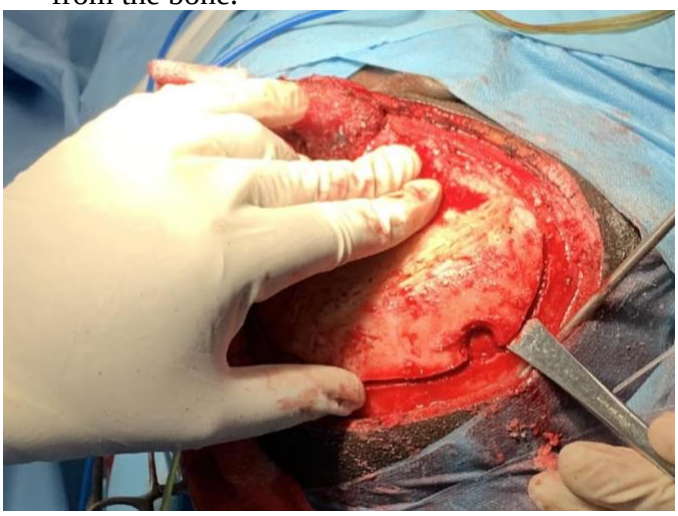


A gentle upward bend is made in the wire blade and then it can be passed from one burr hole to the other and retrieved with a hemostat.



When using the wire saw, spread your arms out as wide as you can to avoid breaking the saw blade. Pull the wire towards yourself while cutting so that an angled cut in the bone is made.

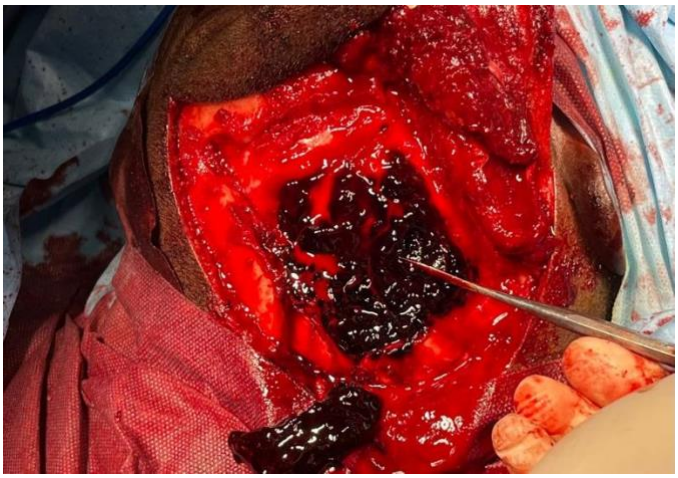
18. Use a periosteal elevator to raise the bone flap off the dura. This layer is adherent to the bone; the outer layer of the dura is the inner skull's pericranium. Go slowly and separate the dura from the bone.



There will be resistance to elevating the bone flap because the dura is adherent to the inner table of the skull. Elevate the bone slowly and then use the elevator to dissect the dura off of the inner table of the bone.

19. In an epidural hematoma, upon raising the bone flap, the hematoma should be in the surgical field. This is gently evacuated under direct vision. The bleeding lacerated vessel is identified and hemostasis is achieved with bipolar diathermy. The field is irrigated and hemostasis confirmed. Leaving a thin layer of coagulated blood adherent to the dura will lead to less blood

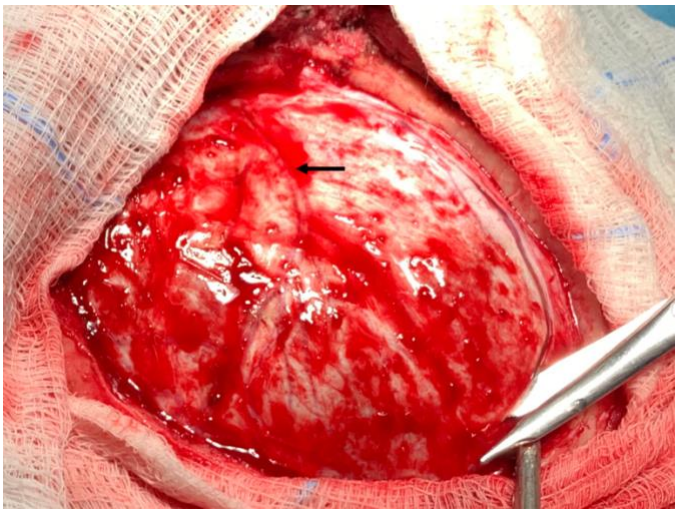
loss, rather than trying to meticulously clear all clot off the dura.



Upon removing the bone flap, the epidural clot is visible. This is gently removed with suction and a fine periosteal elevator.

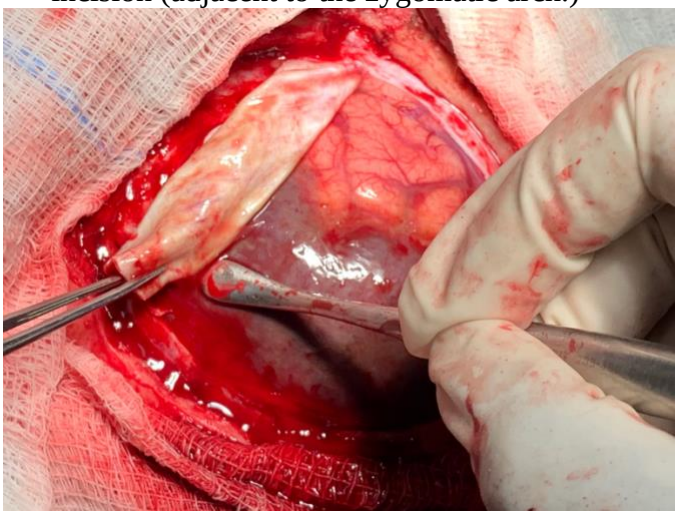
Remove most, but not all, of the blood that is adherent to the dura. Attempting to completely clear the dura of all blood clots actually leads to more bleeding from this surface.

20. In a subdural hematoma or abscess, the pathology is underneath the dura, hence requires durotomy. Make a durotomy using a #15 blade or sharp curved (Metzenbaum or Tenotomy) scissors about 1 cm from the bone cut edge, this will make closure of the dura easier.



Incising the dura circumferentially while preserving its blood supply, the middle meningeal artery (Black arrow.) If you are unable to start your incision with scissors, it is acceptable to carefully use a #15 blade.

21. The dura flap is extended inferiorly on both sides, leaving a wide base at the caudal end of the incision (adjacent to the zygomatic arch.)



The dura is usually not adherent to the surface of the brain, but if there is a loculated subdural hematoma the dura will be adherent to its capsule and must be gently elevated off.

22. With suction and gentle irrigation or a blunt dissector, the hematoma is evacuated.

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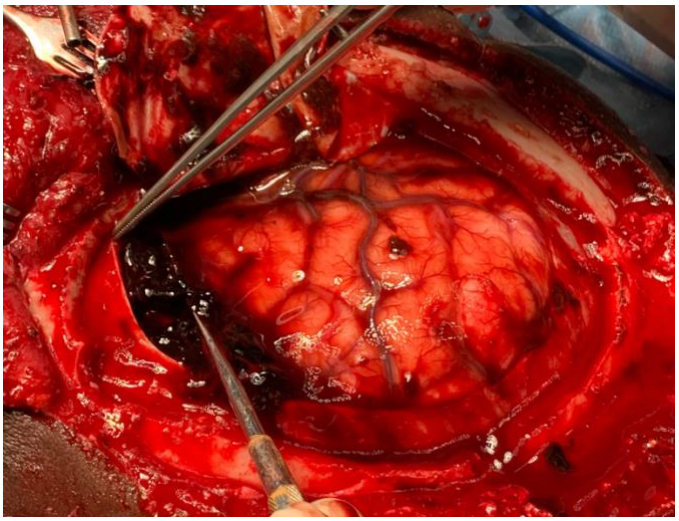
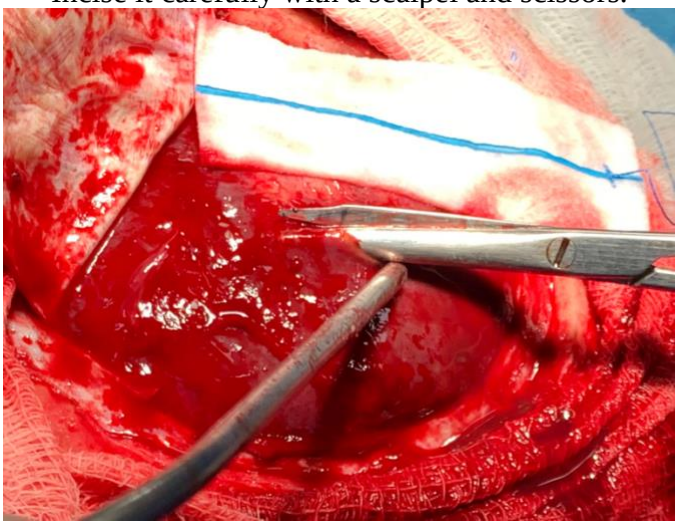


This acute subdural hematoma is not loculated and can be carefully evacuated from the surface of the brain using suction and a fine elevator.

23. In case any bleeding vessels are identified, hemostasis is achieved with bipolar diathermy. Sometimes a bridging vein will retract into the cortex and bleed uncontrollably. This situation should be approached with caution, as there is a risk of suctioning the brain or injuring the cortical vessels if these bleeders are pursued aggressively. If you cannot definitely locate the vein and treat it with bipolar diathermy, it is better to place a piece of surgicel or gelfoam and apply gentle pressure.
24. A loculated subdural hematoma will have a membrane that must be entered sharply and debrided before it can be completely evacuated. Incise it carefully with a scalpel and scissors.



The membrane of a loculated hematoma must be incised before its contents can be cleared. Be extremely careful and meticulous here as you cut right next to the brain cortex.

25. For hematomas extending towards the midline, beware of the sagittal sinus. It can easily be lacerated through careless dissection. Often it is safer to leave residual hematoma than cause a sinus bleed!
26. Topical hemostatic agents like oxycellulose (Surgicel®) or absorbable gelatin (Gelfoam®) can be used at this point. Assure hemostasis, being especially careful on the surface of the brain as described above.
27. If the brain is swelling and preventing dura closure, this can be treated by administering mannitol, hyperventilating, or elevating the head of the bed further. The effect of these interventions are immediately visible, as the brain can be seen to recede again.
28. If the dura has been opened, as for subdural hematoma or empyema evacuation, the dura is re-aligned and closed from one end of the flap using a running suture. We prefer polyglycolic acid (Vicryl®) 3/0 on a tapered needle. Try to take symmetrical bites to avoid uneven edges at the edge of the closure. Avoid excess tension, which causes one side of the closure to "buckle" leading to difficulty approximating the other side.
    - If the dura was damaged by a bone fragment, suture into place the pericranial patch that you harvested previously.
    - If you are unable to close the dura because of brain swelling, lay pieces of Surgicel over the open areas. Refer to instructions below for dealing with the bone flap in this situation.

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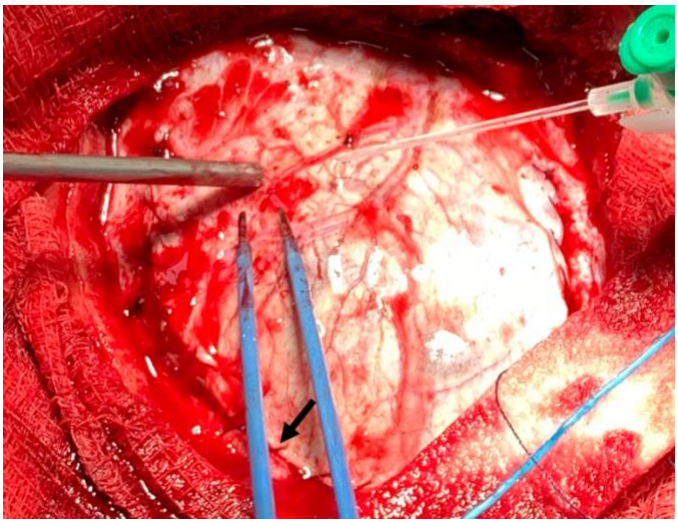
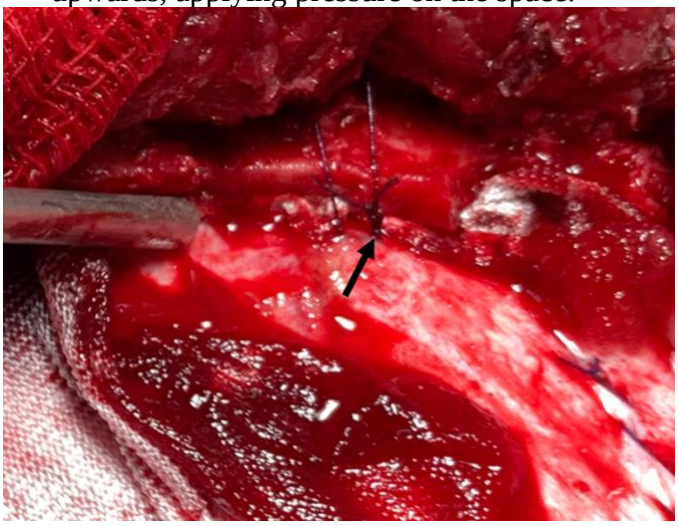


This photograph of the bipolar diathermy being used to obtain hemostasis on the surface of the dura also shows the proper spacing and distance of the sutures used to close the dura (Black arrow.)

29. In case of bleeding from the space between the bone and the dura at the edge of the craniotomy: This can be difficult to treat, especially if associated with a nondisplaced fracture. One option is to stuff a piece of oxycellulose into the space and then to use a suture to pull the dura upwards, applying pressure on the space.

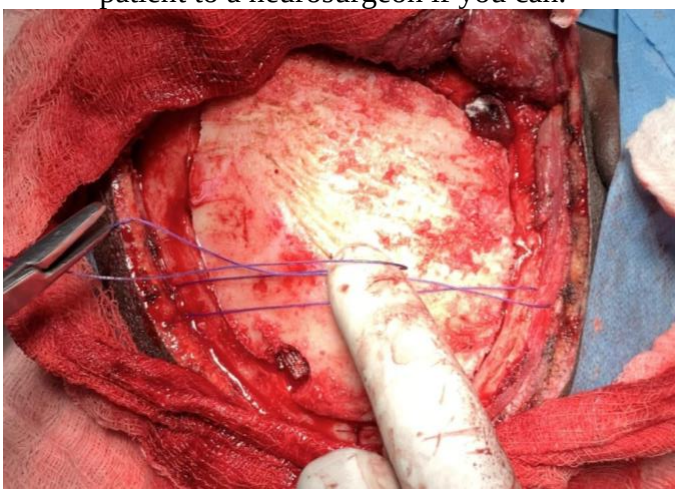


For troublesome bleeding from between the dura and the skull, if no obvious source is found on exploration, stuff a small piece of oxycellulose into the space and tack the dura to the pericranium, pulling it upwards and applying pressure to the space.

30. Replacement of the bone flap: The bone flap is aligned and anchored with absorbable suture

Appropriate bone placement can be guided by aligning the burr holes that were initially made in the skull. Plates and screws can be used if they are available: ones made for this purpose cover the burr hole entirely and allow screws to be placed at the periphery of the plate to anchor the bone flap.

- If the brain swelling is under control but might continue to require intermittent osmolar or hyperventilation therapy, reattach the bone flap with a "hinge craniotomy." Anchor it to the skull on the cranial side only using suture tied through two small holes drilled in the cranial aspect of the bone.
- If the brain swelling is uncontrolled and it is impossible to replace the bone flap, prepare and drape the abdomen, make an incision and place the bone within the subcutaneous fat. The patient must wear a helmet of some kind to protect the brain while the bone is not in place. The bone can be replaced once the swelling has gone down, but if the dura was also damaged the brain is vulnerable to injury during elevation of the scalp flap. Refer this patient to a neurosurgeon if you can.



Suture anchored to the pericranium on either side of the flap is is tied down to hold the bone in place: repeat this maneuver 3 or 4 times to secure it well.

Pitfalls

- Injury to the brain while drilling the burr-holes. This can occur while using the non locking Hudson brace perforators, once the cortical bone

has been penetrated, often the bleeding from the bone is noted to increase. At this point the surgeon should look out for change in consistency to the "feel" of the brace as it is turned. This is an indicator to stop and check whether the inner table has been breached. One can probe with a hemostat or side-biting rongeur as a guide and begin to incise the bone at this point.

- Injury to the dura and the middle meningeal artery. Sometimes this happens because the artery passes through the part of the bone that is cut. Blood coming from a canal in the bone can be controlled with bone wax.
- The dura is often more adherent to the zygomaticotemporal bone and is prone to injury while cutting the bone flap with a power drill.
- Brain herniation after evacuation of the hematoma: It is not uncommon for the brain to expand significantly and herniate through the durotomy after the hematoma has been evacuated. This can pose a dilemma. A bolus of mannitol can be given to help relax the brain, however this should only be used in an adequately resuscitated patient. Harvesting a peri cranial flap (as described above) can help with the closure of the dura. It is acceptable to create an abdominal subdermal pouch for storage of the bone flap. If the facility has a freezer for tissue storage, this can also be used to keep the flap and cranioplasty done at a later time.

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