External Ventricular Drainage (Ventriculostomy) placement

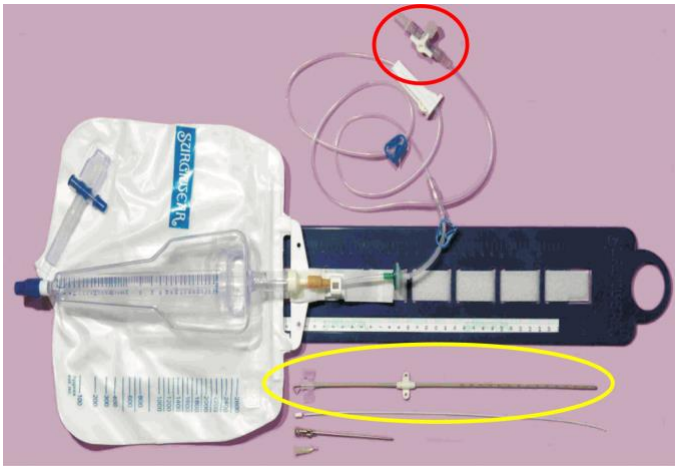
Pitman Mbabazi, Richard Davis

Introduction:

External Ventricular Drainage is placement of a closed system for drainage of cerebrospinal fluid. It involves a catheter placed into the lateral cerebral ventricle, connected to an external collecting system. It can be used in cases of raised intracranial pressure including but not limited to intra ventricular hemorrhage, meningitis, hydrocephalus, and traumatic brain injury. The procedure requires a drainage set. The Chhabra system, available from Surgiwear (http://www.surgiwear.co.in) is an example of a system that is commonly used in low-resource settings. Also required are a Hudson Brace or electrical craniotome, a leveling device (also called a precision spirit leveler,) and the standard drapes.

The procedure is usually performed under general anesthesia. However, depending on the prevailing patient status, it can be performed under local anesthesia with or without sedation.

Confirm that all the components of the system are available and functional beforehand. Flush the catheter and ensure it has a seamless flow.



Ventricular drainage kit containing a catheter and stylet (Yellow circle) and a 3-way stopcock (Red circle) to be used as described below. Source: http://www.surgiwear.co.in/files/index/download/id/1455790751

External ventricular drain placement can be divided into three major steps.

- Site location and burr hole placement.
- Placement of ventricular catheter.
- System set up and closure.

Steps:

1. With the right patient, review of the CT scan images is key to plan for the catheter placement site. The EVD catheter is commonly placed in the anterior horn of the lateral ventricle via Kocher's point, or the posterior horn of the lateral ventricle via an occipital entry point.

Axial CT scan images showing a large right intraventricular hemorrhage in a patient with longstanding untreated hypertension. We chose to place a drain into the anterior horn of the left ventricle, bearing in mind that the left ventricle was compressed by the hemorrhage on the right.

2. With patient in supine position, a head ring is used to stabilize the head, land marks are clearly labelled. Kocher's point is located as shown in the image below: its is located about 2cm anterior to the coronal suture, 2-3cm lateral to the midline in the sagittal plane. Also, an intersection between a line though the mid-pupillary line and a line 2cm anterior to the tragus is an acceptable landmark of entry.

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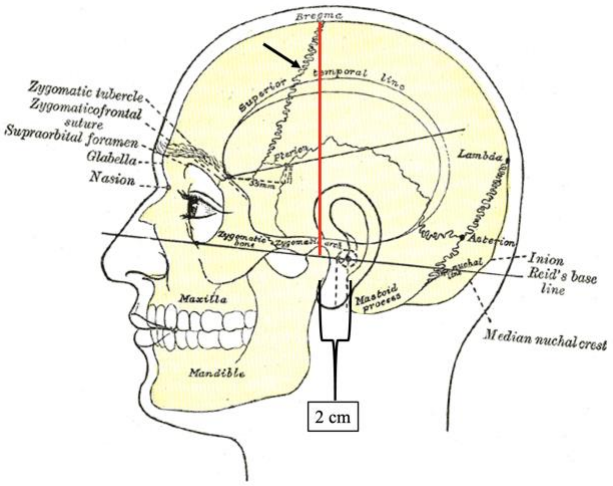
The coronal suture is usually palpable through the scalp, especially if the head is shaved or the hair is thin. Sometimes, by positioning the overhead light exactly right, it can be seen as a shadow on the scalp, as in this photo (Black arrow.) This is a 4 year old child with longstanding hydrocephalus; even in children with enlarged heads, the landmarks described here still apply.



As shown here, a vertical line can be drawn from 2cm anterior to the tragus or external auditory meatus. This line will very nearly intersect with the coronal suture (Black arrow.) If you can not palpate the coronal suture, draw this line and use it as described in the next picture. Be sure to find the coronal suture after incising the scalp if you use this technique.

A line extending posteriorly along the midline from the nose is drawn. A line passing through the pupil, parallel to the midline, is then drawn. A point 2cm anterior to where the mid-pupillary line crosses the coronal suture is then shown (marked by an "X" in this photo.)

3. The right side is usually the preferred side of placement however, the contra-lateral side is acceptable depending on the circumstances.

Another view of a line extending posteriorly from the glabella (just above the "bridge" of the nose) and another line passing through the mid-pupillary line, parallel to the midline. The surgeon is palpating the coronal suture with an index finger.

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Having drawn another dotted line along the coronal suture, the surgeon then marks the incision so that the burrhole will be 2 cm anterior to the coronal suture. Use betadine rather than alcohol-chlorhexidine for sterile preparation so that the line remains visible.

4. Standard draping is done with aseptic technique. Infiltrate local anesthetic agent with epinephrine the planned incision site

Injecting epinephrine-containing anesthetic into the planned incision: the sooner this is done before the actual incision, the less bleeding there will be.

An "amateur" neurosurgeon is wise to drape in such a way that the eyebrow and the upper earlobe can be seen, to make orientation more obvious. This is especially true if the previously made marks are washed away by the preparation solution.

5. The surgeon and assistant stand at the head of the patient. A 3-4 cm longitudinal incision is made at the Kocher's point through skin and subcutaneous tissues. Complete the incision to the bone with a diathermy to minimize bleeding from the scalp vessels. At this point, confirm that you are anterior to the coronal suture.
6. A periosteal elevator is used to adequately dissect the periosteum off the bone. It is paramount to locate the coronal suture line and be sure the burrhole is anterior to it. Then a self retaining (such as Weitlaner) retractor is placed to maintain exposure.

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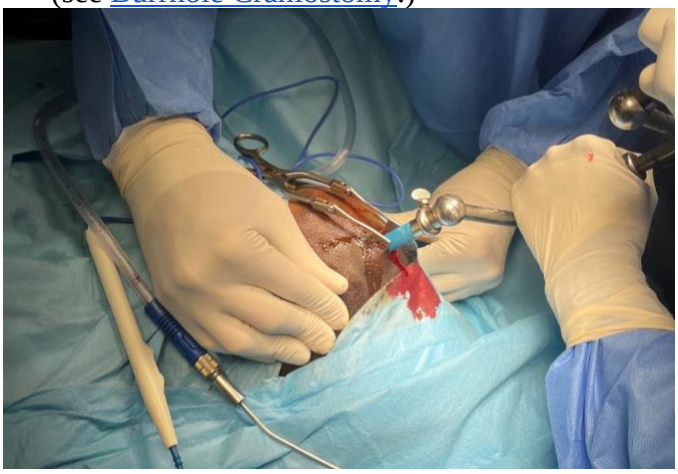
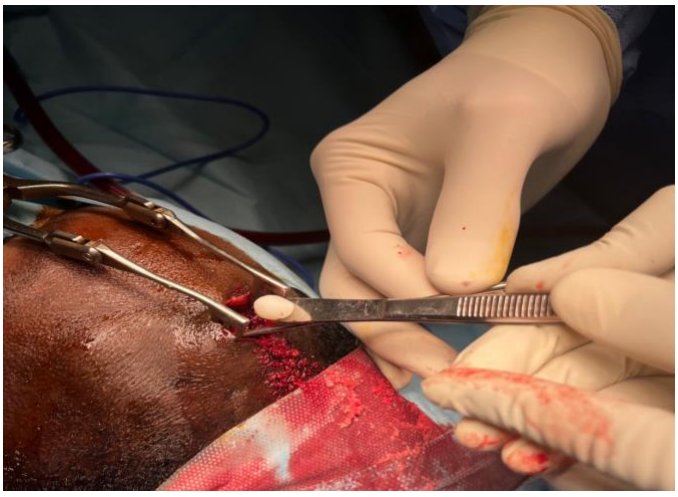
After incision through the skin, galea, and pericranium, the pericranium is elevated with a periosteal elevator. Palpate the coronal suture and make sure your burrhole will be 2 cm in front of it. Place a self-retaining retractor to hold all these layers out of the way.

7. The site placement is located and marked 2-3 cm anterior to the suture line. A burr-hole is drilled (see Burrhole Craniostomy.)



As shown here, the table is lowered to about the level of the surgeon's waist. An assistant then steadies the head while the surgeon makes the burrhole with the Hudson brace. Continuous slow irrigation with normal saline prevents the bone from overheating. Check the depth periodically to make sure you are not in danger of plunging the perforator through the bone into the brain.



Occasionally the bit will pass through a venous sinus within the bone. If this occurs, use a small (Penfield) elevator to apply sterile bone wax to the area of bleeding. If you do not have a small elevator, use the opposite end of a small forceps, as shown here.

8. Once the dura is visible, confirm that your dural incision will not lacerate a blood vessel and make a cruciate incision in the dura, being careful not to damage the brain underneath.

After the burrhole is made, use a small scalpel blade to make a cruciate incision in the dura. Be careful to cut only the dura, as the brain will be very close underneath it, especially if intracranial pressure is elevated.

9. The catheter is held perpendicular to the skull in all planes. Verify that there is a perfect 90 degree angle between the catheter and the skull before advancing it. It is then advanced through cerebral tissue until a "give" or "a pop" is felt as it perforates the ventricular wall. Usually this occurs when the catheter is at 5 to 7 cm into the brain parenchyma. At this time backflow of CSF is noted through the catheter, around the stylet. Advance the catheter gently over the stylet no more than 1cm. Then the stylet is carefully removed while holding the catheter at its current depth. Opening pressures can be measured if indicated or CSF samples collected if necessary.

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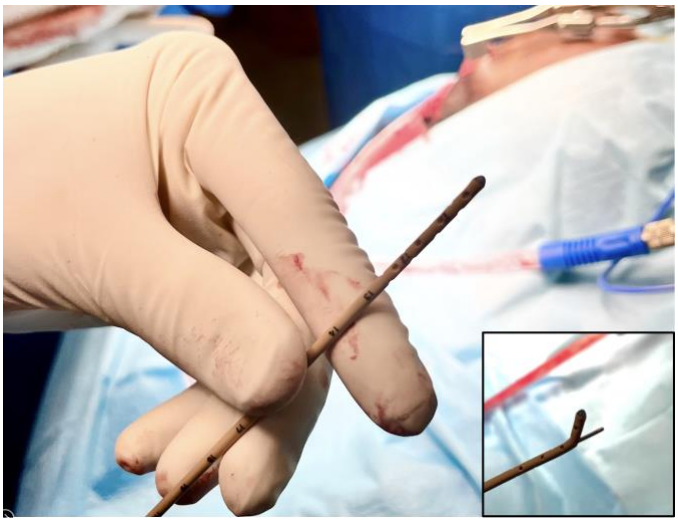
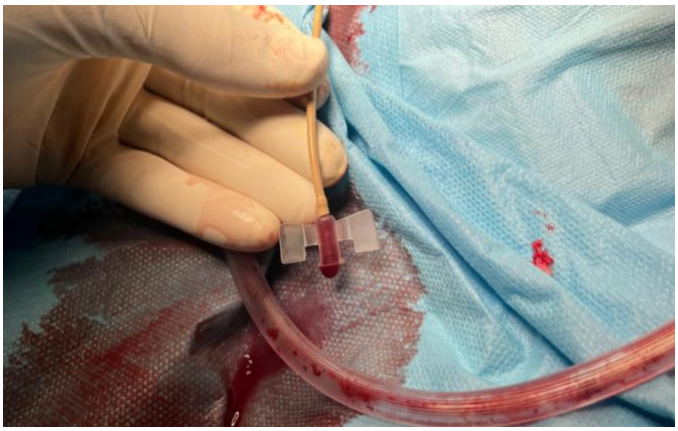


Detail of the tip of the catheter with the stylet inside. When the catheter is held properly, with some tension on the stylet, the tip of the stylet is contained within the tip of the catheter. If the catheter and stylet are not held properly (inset,) the stylet can come out of one of the side holes of the catheter and cause damage.

Hold the catheter and stylet as shown, with the index finger keeping gentle pressure on the stylet while the thumb and other fingers pull the catheter upwards as you advance it.



When the catheter enters the ventricle, a small amount of fluid should come through the catheter around the stylet. Advance the catheter about 1cm without withdrawing the stylet, then remove the stylet without allowing the catheter to move. You should then get clear or slightly bloody cerebrospinal fluid through the catheter. If fluid does not come out, gently pull the catheter back, about 3-5mm at a time, until fluid comes out. Repeat catheter insertion if necessary.

10. The catheter is tunneled under the skin and exteriorized 3-4cm from the incision site. The ventricular system is anchored to skin with a non absorbable suture and connected to the drainage system. Confirm CSF flow before closure.

Using the provided trocar, the catheter is passed under the galea and skin to exit separate from the incision site.

11. The incision is closed in layers: galea with absorbable 2-0 suture and Nylon 1 for skin. Avoid entrapping the catheter in the suture and check again for flow after closure.

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A view of the wound before closure, showing the catheter just deep to the galea and skin. Take care not to entrap the catheter the sutures as you close. Recheck flow after wound closure.

12. Secure the drain to the skin well, preferably in three places. Insert a 3-way stopcock to allow the drain to be closed later, or aspirated and irrigated (using strict sterile technique.) Check the flow again after securing the drain. Loosen and redo any suture that constricts the tubing.

The drain is secured in several places. Note that a 3-way stopcock should be inserted in between the catheter and the tubing, in the area indicated by the Red circle. This allows you to gently flush and aspirate the catheter, under sterile conditions, to unblock it if necessary.

13. Nurse the patient with awareness of the drip chamber of the collecting system. The drip chamber functions as the level of the drainage, as follows:
    - Initially, keep the tubing open and the drip chamber at the same level as the tragus of the patient's ear. Use the precision spirit leveler to obtain the zero position relative to the patient's ear.
    - Alternatively, measure intracranial pressure by placing the bottom of the ruler at the level of the tragus and raising the drip chamber to the level where fluid no longer comes out. It is also possible to raise the drip chamber to a level less than 20, to maintain intracranial pressure in this range while avoiding overdrainage.
    - As the patient improves and no longer requires ventricular drainage, clamp the tube intermittently using the stopcock. One technique is to open it for 10 minutes every 6 hours. If the patient deteriorates, return it to continuously open. If the patient remains stable and the output is minimal, the catheter can be removed.

A ventricular drain collecting system with the ruler set up vertically, with "zero" at the level of the tragus of the patient's ear. The drip chamber can be raised and lowered as described above. Source: Rmosler2100, CC BY-SA 3.0 via Wikimedia Commons

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Pitfalls

- Bleeding from the scalp can be remarkable, hence precise hemostasis should be achieved. Placement of a self-retaining (Weitlaner) retractor can tamponade the bleeding vessels.
- Injury to the premotor or motor cortex: assuring that the burrhole is placed anterior to the coronal suture assures that the catheter will pass into the anterior portion of the frontal lobe.

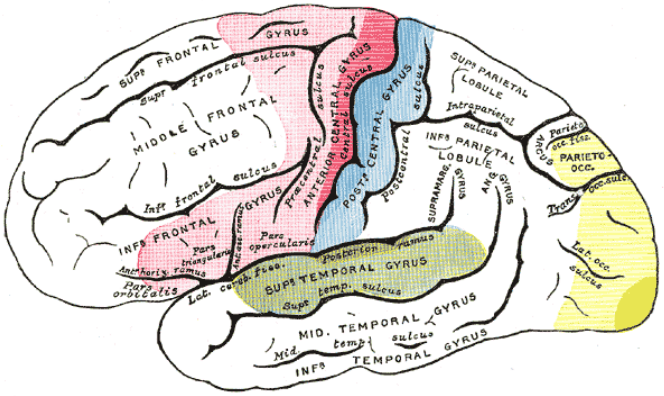

Illustration of the left cerebral cortex, demonstrating the motor (Red) and premotor (Pink) cortexes. Place the burrhole anterior to the coronal suture, to assure that the catheter passes through the frontal lobe and damage to cerebral motor structures is avoided.

- Failure to cannulate the ventricle. Avoid over advancing the catheter beyond 8-9cm. If there is no CSF flow, withdraw the catheter and adjust the angle of approach. If the first attempt, perpendicular to the skull, does not succeed, on the second attempt aim towards the medial canthus of the contralateral eye.
- Blockage of the catheter: this is more likely with bloody fluid. If a catheter stops working, either immediately after insertion or later on in the ward, try to gently irrigate it with sterile saline and then aspirate it. If fluid enters but does not exit, the catheter may be blocked, or it may be malpositioned. If you are not able to dislodge it and the patient still needs ventricular drainage, you must place a new one. This should be done in the operating room, under sterile conditions. If catheter infection is not suspected, place the new drain through the same burrhole**.** Alternatively, make a new burrhole on the contralateral side.
- Overdrainage: if the drip chamber, or the entire collecting system, is left below the level of the patient's head for a long time, it can overdrain the cerebrospinal fluid. Severe headache will result. Return the drip chamber to the proper level and allow the fluid to reaccumulate.
- There is a very high risk of dislodging: ensure the catheter is anchored to the skin appropriately and be careful when shifting or transporting the patient.

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