External Ventricular Drainage (EVD, Ventriculostomy)

Last updated: January 12, 2025

INDICATIONS **1**
CONTRAINDICATIONS **1**
PLANING PRIOR TO PROCEDURE **1**
EQUIPMENT **1**
CRANIAL ACCESS KIT 1
CATHETER 1
CSF COLLECTION 2
Codman EDS 3™ CSF External Drainage System 2
INTRAPARENCHYMAL ICP MONITOR 2
Codman ICP EXPRESS® Monitoring System 2
CONTINUOUS ICP MONITORING AND CSF DRAINAGE 2
Integra Camino Flex 2
InnerSpace Neuro Hummingbird Ventricular System 2
CSF DRAINAGE AND INTERMITTENT IRRIGATION 2
IRRA*flow* System 2
ANESTHESIA AND ANTIBIOTICS **3**
ANTERIOR (FRONTAL) APPROACHES **3**
KOCHER'S POINT 3
KAUFMAN'S POINT 5
TUBBS' POINT - EMERGENCY VENTRICULOSTOMY 5
PAINE'S POINT - INTRAOPERATIVE VENTRICULOSTOMY 6
Hyun point 6
Park point 6
MENOSKY'S POINT - INTRAOPERATIVE VENTRICULOSTOMY 6
POSTERIOR (OCCIPITAL) APPROACH **7**
KEEN'S POINT 7
FRAZIER'S POINT 7
DANDY'S POINT 8
SANCHEZ'S POINT 8
SECURE DRAIN TO SCALP **9**
FURTHER MAINTENANCE, DRAINAGE HEIGHT **9**
REPLACEMENT OF CATHETER **9**
COMPLICATIONS **9**

INDICATIONS

1. ICP monitoring (EVD is a gold standard)
   Before leaving OR, ventriculostomy should be placed in all patients with initial GCS score of 8 or less because raised ICP requiring treatment develops in at least 80% of these patients; it may also be placed under direct vision before closure of bone flap.
2. CSF drainage in:
   1) intracranial hypertension
   2) shunt infection
   3) SAH (but ↑ risk of bleeding if aneurysm is unsecured)
   4) intraoperative brain relaxation

CONTRAINDICATIONS

1. Hemostasis disorder
2. Mass lesion in catheter path
3. Extensive midline shift – both hard to pass catheter and EVD can cause further shift

PLANING PRIOR TO PROCEDURE

- **review imaging studies** (CT or MRI) for ventricular size and any shifts.
- make sure coagulation parameters are acceptable and patient is not on antiaggregants.
- if long duration of external drainage is suspected, perform procedure in OR with tunneled distal system.
- plan ventriculostomy such that future shunt requirements are considered in effort to maintain clean shunt tract.

EQUIPMENT

1) hair clipper
2) marking pen with ruler
3) sterile prep swabs, sterile gloves
4) sterile towels, gauze, and clear plastic drape
5) 25G and 22G needles
6) sterile saline solution
7) scalpel
8) handheld cranial twist drill
9) 3.0 nylon sutures
10) needle driver, forceps, scissors
11) standard ventricular catheter
12) external drainage collection kit

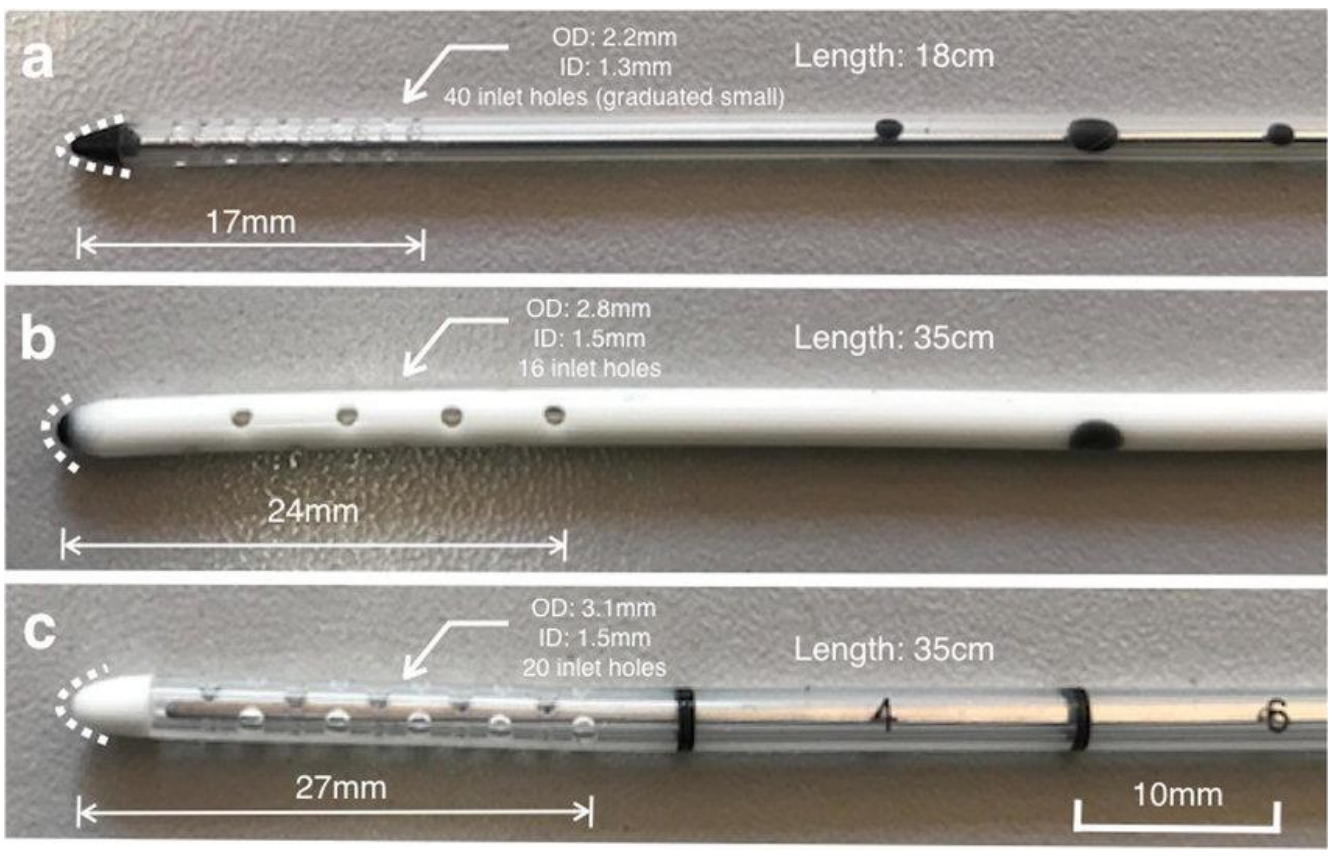
CRANIAL ACCESS KIT

Codman: https://www.depuysynthes.com/hcp/codman-neuro/products/qs/Cranial-Access-Kit

CATHETER

Becker (white in color) – for TBI, no blood in CSF.
DePuy Codman® Bactiseal (orange in color) - has 0.15% CLINDAMYCIN and 0.054% RIFAMPICIN infused into silicone matrix at molecular level. >>

Plain silicone polymer ventricular catheters (dashed white line indicates the contour of the catheter tip. OD, outer diameter; ID, inner diameter):
2.2-mm Integra™ catheter
2.8-mm Medtronic™ catheter
3.1-mm Codman™ catheter



CSF collection

CODMAN EDS 3™ CSF EXTERNAL DRAINAGE SYSTEM

https://www.depuysynthes.com/hcp/codman-neuro/products/qs/EDS-3-CSF-External-Drainage-Syst

INTRAPARENCHYMAL ICP MONITOR

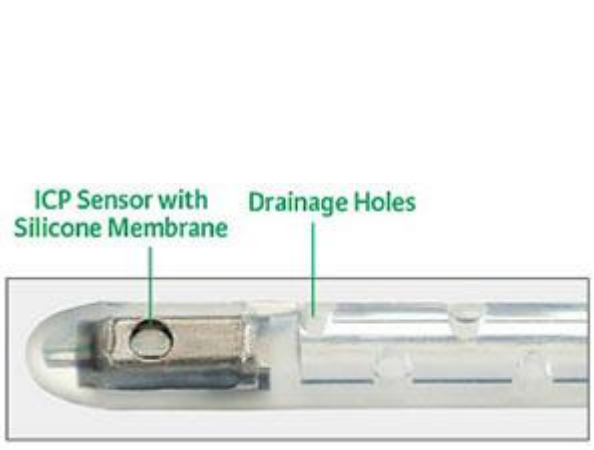
CODMAN ICP EXPRESS® MONITORING SYSTEM

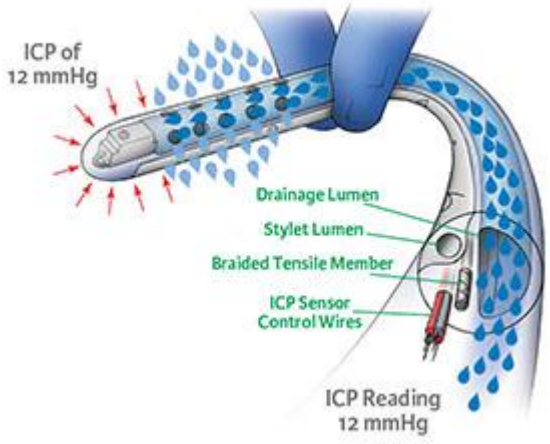
https://www.depuysynthes.com/hcp/codman-neuro/products/qs/ICP-EXPRESS-Monitoring-System

Continuous ICP monitoring and CSF drainage

INTEGRA CAMINO FLEX

– safe in MRI 3.0 T; pressure sensor inside ventricle (at catheter tip):





INNERSPACE NEURO HUMMINGBIRD VENTRICULAR SYSTEM

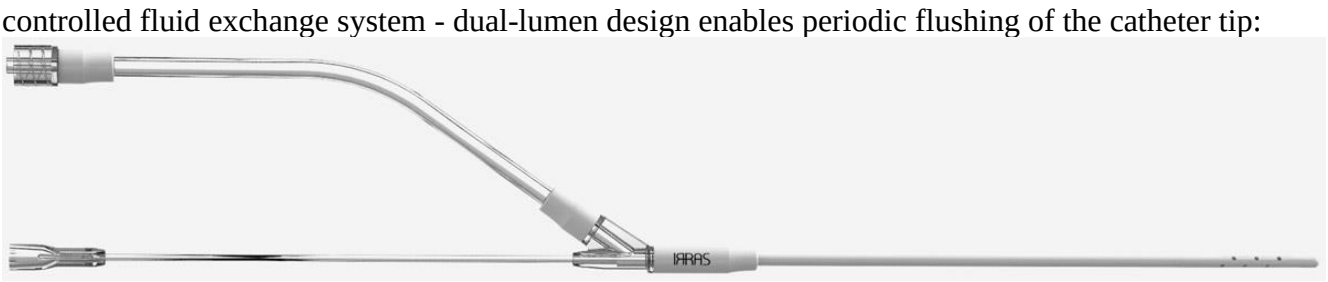
– MRI Conditional 1.5T/3.0T; pressure sensor intraparenchymal:

CSF drainage and Intermittent Irrigation

IRRA*FLOW* SYSTEM

https://irras.com/product/introducing-irraflow/#

- controlled fluid exchange system - dual-lumen design enables periodic flushing of the catheter tip:



- control unit and disposables (dual-lumen catheter and tube set):

ANESTHESIA AND ANTIBIOTICS

1. 1 % LIDOCAINE
2. Short-acting IV sedation (VERSED or PROPOFOL if intubated)
   Avoid paralytics if possible to make neurological exam post EVD placement meaningful!
3. Not routine - IV antibiotics covering routine skin flora; some experts continue while EVD is in place.

ANTERIOR (FRONTAL) APPROACHES

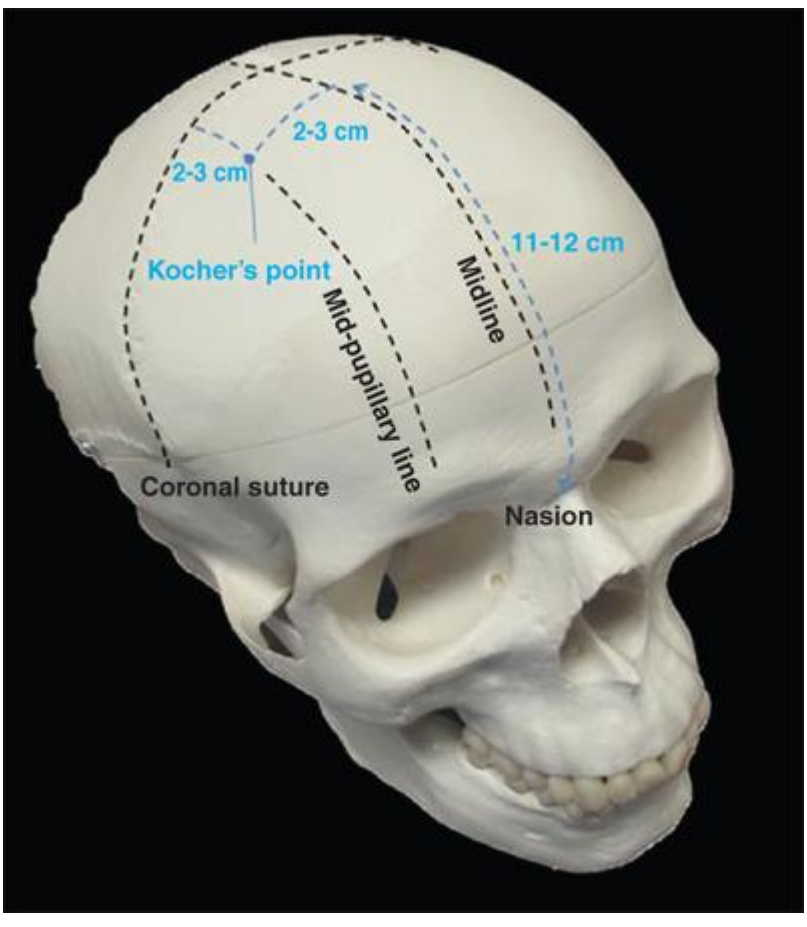
- in front of external auditory canal.

- EVD is placed on right side to minimize risk of injury to dominant hemisphere, unless left-sided intracerebral hemorrhage patient.
- patient supine with head of bed slightly elevated (20°) and neck in neutral position.
- appropriate side of head is liberally clipped to allow for adequate subgaleal tunneling of catheter
- entry point on scalp is marked with pen and ruler.
- clear drape is placed, taking care to clearly define midline.
- 1% LIDOCAINE is injected subcutaneously at planned incision site; make large bleb – will help for subgaleal tunneling anesthesia.
- drill-bit depth guide is set to allow penetration of inner and outer calvarial tables.

KOCHER'S point

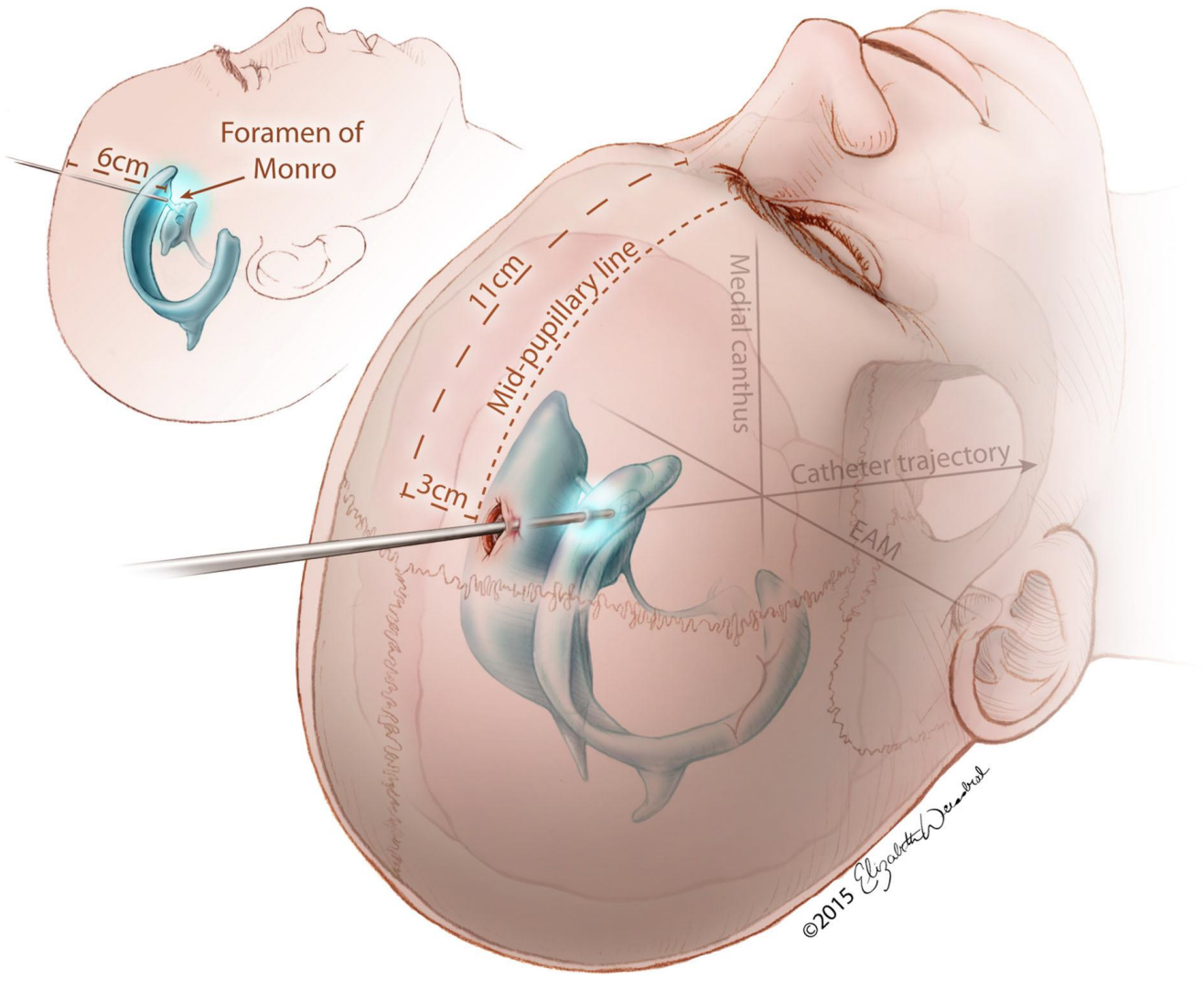
(most commonly used site)

- Kocher's point is thought to be named after the Swiss neurosurgeon Emil Theodor Kocher (1841-1917), however, Cushing and Tillmanns are credited with describing the first ventriculostomy through this point
- lies anterior to motor strip, is posterior enough to avoid incisions on forehead, and is lateral to both superior sagittal sinus and large bridging veins draining frontal lobes into sinus; <u>location</u>:
  - measure 11 (10-12) cm in sagittal line posteriorly from nasion (it should be 1-2 cm anterior to coronal suture) then 3 cm laterally – mark entry point here (should more or less coincide with sagittal plane going through midpupil);
  - at posterior part of incision must see coronal suture (extend incision appropriately) – burr 1-2 cm anterior to coronal suture!



- 1-3 cm parasagittal stab incision is made with scalpel at marked site just large enough to permit passage of drill bit (in order to minimize scalp bleeding); incision is taken down to bone.
- scrape to sides pericranium with scalpel handle.
- twist drill is held perpendicular to skull to make hole in skull; irrigate away bone chips!!!
- use drill to puncture dura (by turning handle back and forth for several times), but take care not to plunge into brain parenchyma; if dura still intact – use drill bit spinned in your fingers or #11 blade or catheter tunneling needle.
- drill wrench or spinal needle is inserted through burr hole to determine if dural opening is large enough to pass catheter (if attempt is made to pass catheter and wire stylet with dura intact, epidural hematoma may develop from dura stripping; furthermore, if dural opening is too small, catheter may drag on dura, allowing stylet to puncture catheter and protrude into brain parenchyma).

<u>Trajectory</u>



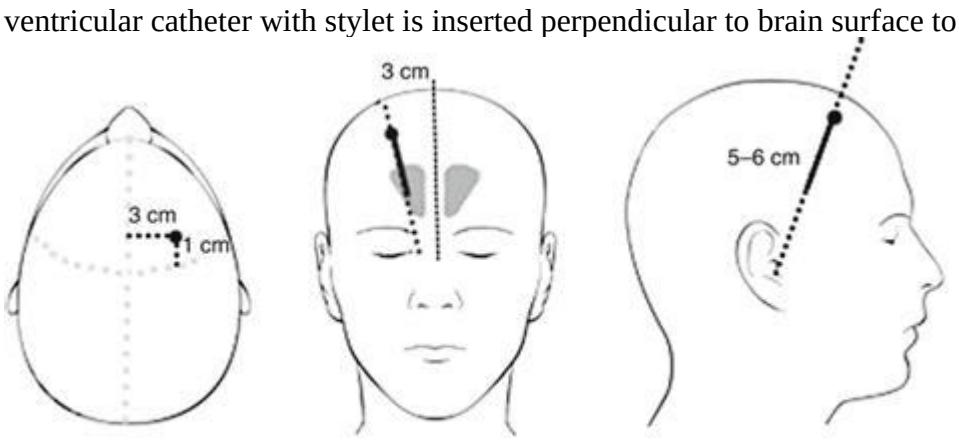
2015 Elizabeth N. Weissbrod

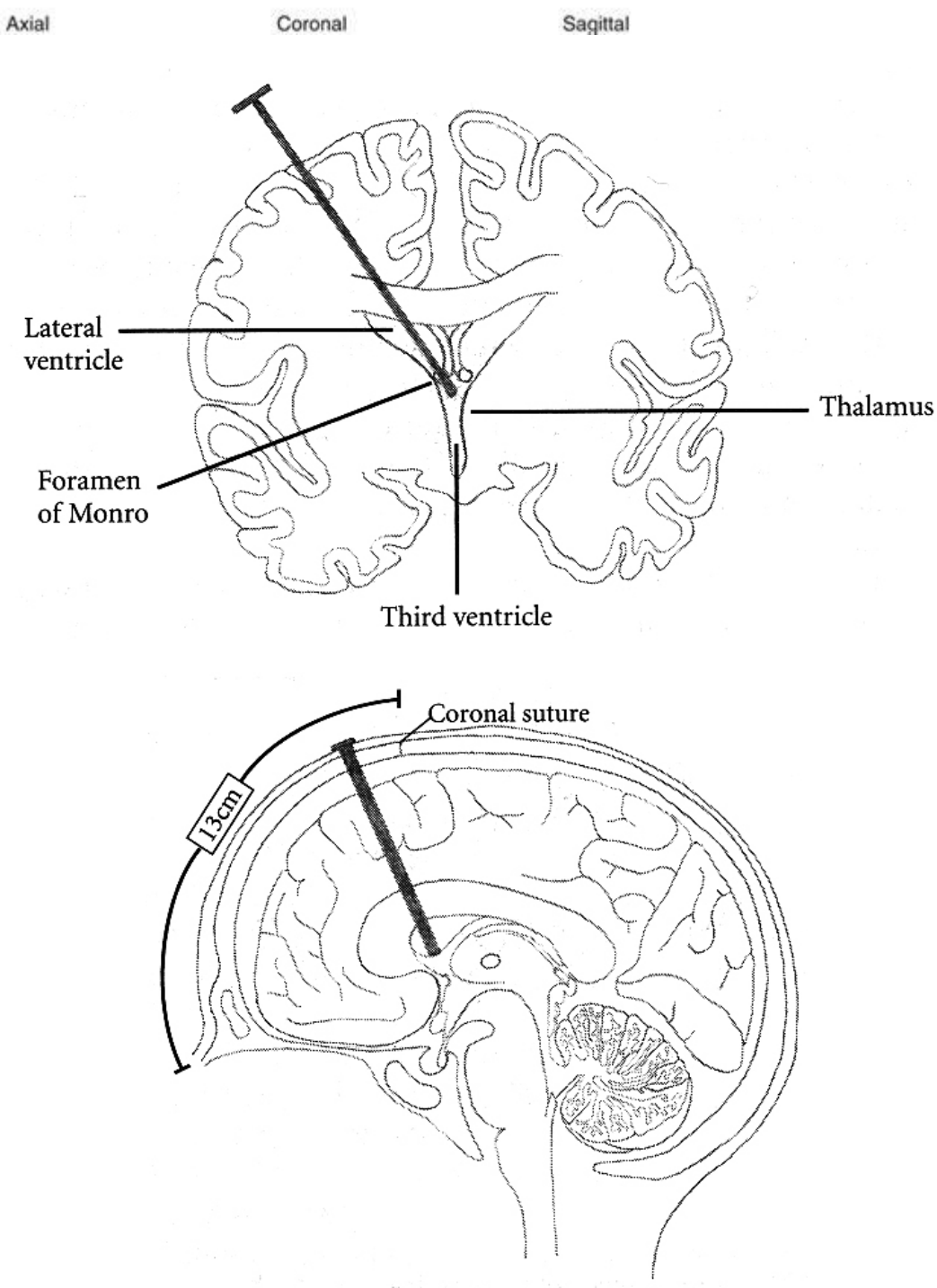
In bilaterally symmetric plane crossing entry point and (point 2 cm anterior* to) **tragus**. Keep catheter in this plane and aim towards ipsilateral **nasion / glabella / medial canthus** (check this on coronal CT).

*2 cm anterior to tragus might be too anterior.

N.B. most common mistake – inserting too anterior and too lateral.

- practically, aim catheter towards anterior to tragus then move in plane towards medial canthus.
- ask helpers to watch from side (that you still stay in plane) and from end of bed (to make sure that you entering ***skull perpendicularly to surface***).
- **drawing lines** (from entry point to tragus; another line from entry point to medial canthus) with pen on scalp is very helpful to orient catheter once landmarks are covered by drapes; another trick – place **ECG pad at nasion** – can palpate through drapes.
- ventricular catheter with stylet is inserted perpendicular to brain surface to depth of 6 cm:





Depth of catheter insertion

Target – catheter tip above foramen of Monro (*choroid plexus* travels through foramen – may block catheter if it is placed inside foramen).

Adults – 6* cm from outer table of skull; no need to insert catheter > 6 cm; if properly directed, catheter will encounter CSF at 4 cm depth (even if you encounter CSF, advance to 6 cm, so collapsing ventricle won't dislodge catheter).

* if CSF flow is obtained prior to 6 cm, may advance further (up to 10 cm) without stylet – so catheter "finds way" (soft pass) to foramen of Monro

Pediatric patients - estimated from CT.

- stylet is withdrawn to ensure CSF flow.

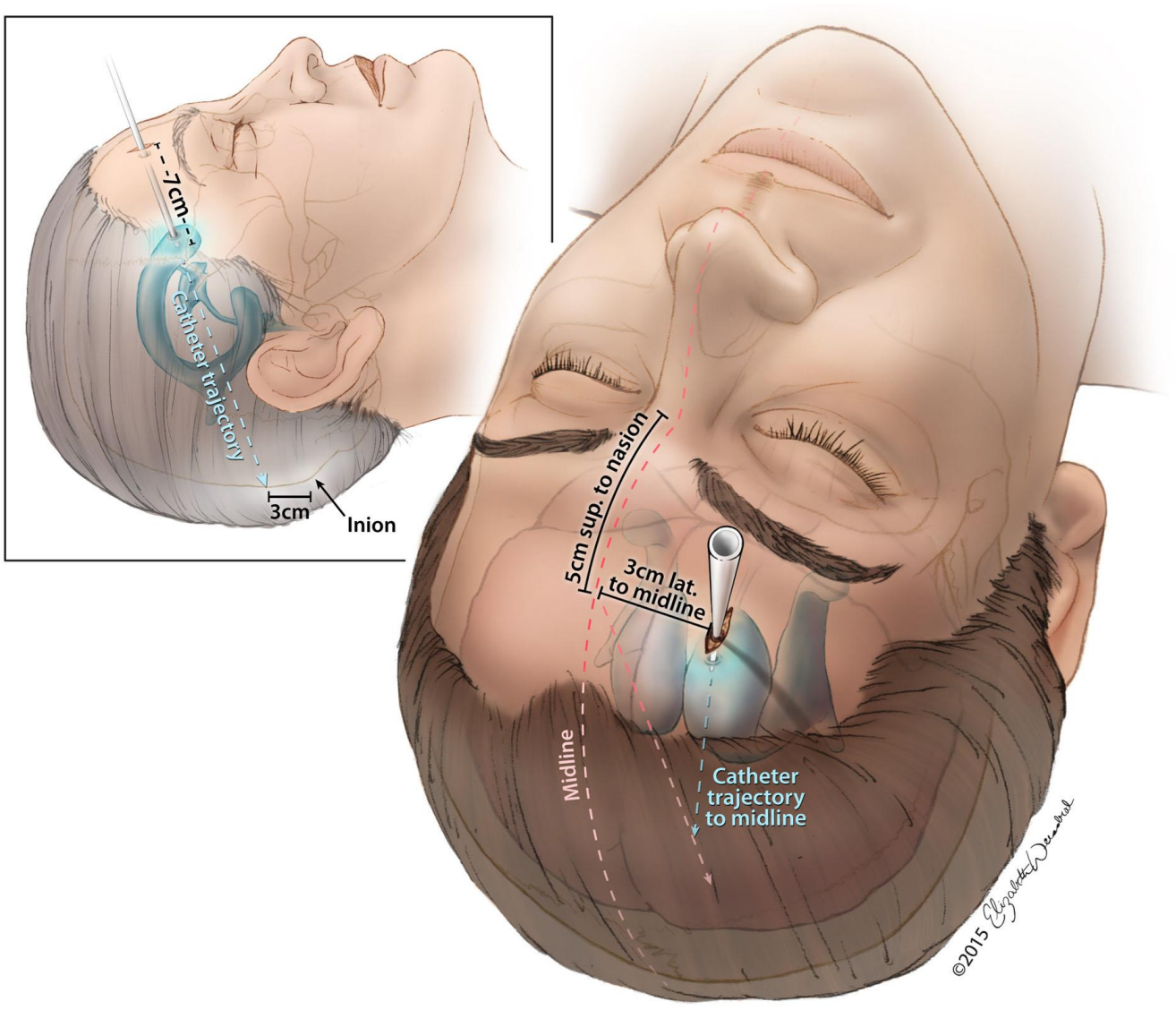
- if CSF flow does not start immediately after catheter insertion, problem may be air lock in catheter lumen; it can be eliminated by gentle irrigation with small quantity of saline, and distal end of catheter may then be lowered in order to siphon ventricular CSF; if CSF flow is established only transiently, catheter may be in temporal horn, interhemispheric fissure, third ventricle, sylvian fissure, or even basal cisterns.
- unsuccessful attempt: if no CSF flow is obtained at 6 cm, tendency to insert catheter further must be resisted;
  - catheter should be removed without stylet and flushed with saline
  - landmarks and trajectory should be confirmed.
  - stylet is reinserted, and catheter redirected (aiming catheter slightly more medially is usually safe and effective way to establish CSF flow).
- tunneling device is attached to distal end of catheter; while stabilizing catheter proximally as it enters skull, tunnel distal portion under galea medially* to exit site at least 5 cm distant from entry site; CSF flow is confirmed after catheter is pulled flush against skull.

  *i.e. towards midline – if patient will need shunt, it will go laterally from burr hole

  N.B. frequently (after every step) check for CSF flow but otherwise keep catheter always clamped!
- distal end of catheter is connected to adapter and then to pressure transducer and/or drainage system; fixed level for drainage is set using external auditory meatus as reference point.
- suture to scalp – see below >>

KAUFMAN'S point

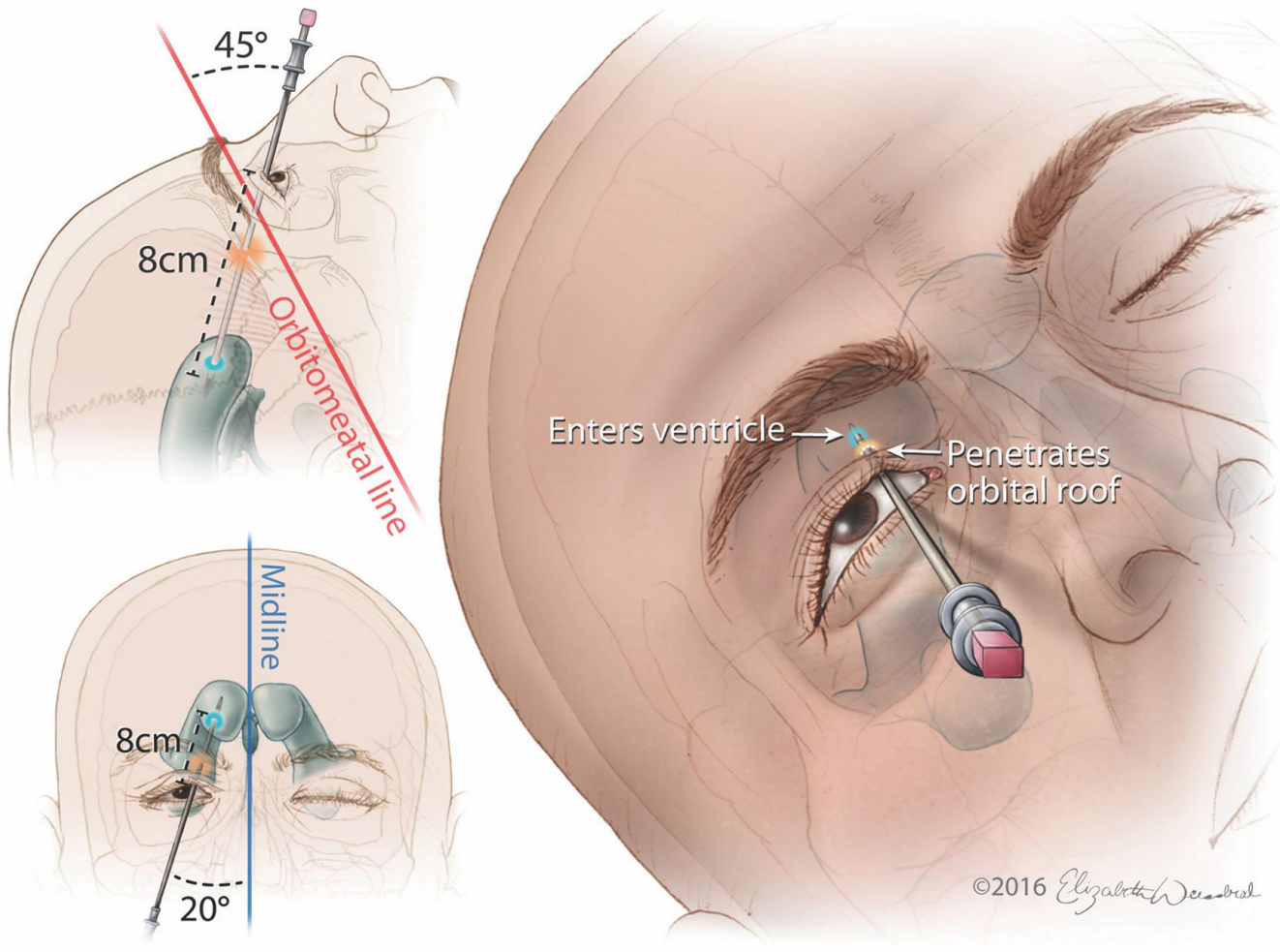
Entry - 5 cm superior to the nasion and 3 cm lateral to midline.
Trajectory: aim toward the midline and inferiorly toward a point that is 3 cm superior to the inion; catheter should
be passed approximately 7 cm.
Advantage – no hair shaving is needed
Disadvantage - cosmesis



2015 Elizabeth N. Weissbrod

TUBBS' point - emergency ventriculostomy

- for herniating kids in ED.
- transorbital route with 18G 3.5 inch spinal needle.
- needle tip is placed under the upper left or right eyelid → trajectory is 45º superior to the orbitomeatal line and 20º toward the midline (towards the opposite parietal bossing
- 0.
- orbital roof should be penetrated just medial to the midpupillary line and posterior to the superciliary arch.
- after advancing spinal needle approx. 8 cm, frontal horn will be cannulated.
- risk of a globe injury and requires blind puncture of the orbital roof.



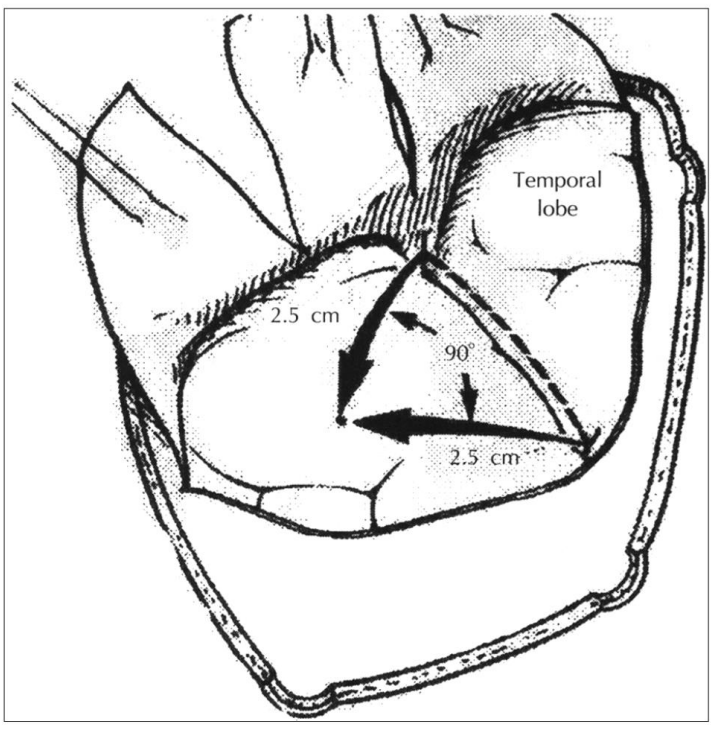
2016 Elizabeth N. Weissbrod

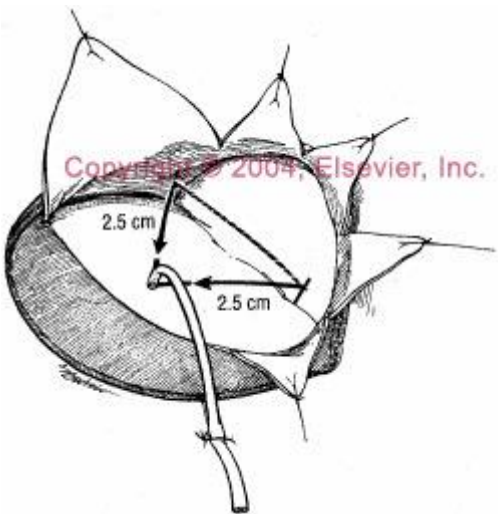
PAINE'S point - intraoperative ventriculostomy

PAINE's point (during pterional craniotomy – to drain CSF and minimize brain retraction injury) - creation of 2.5-cm isosceles right triangle:

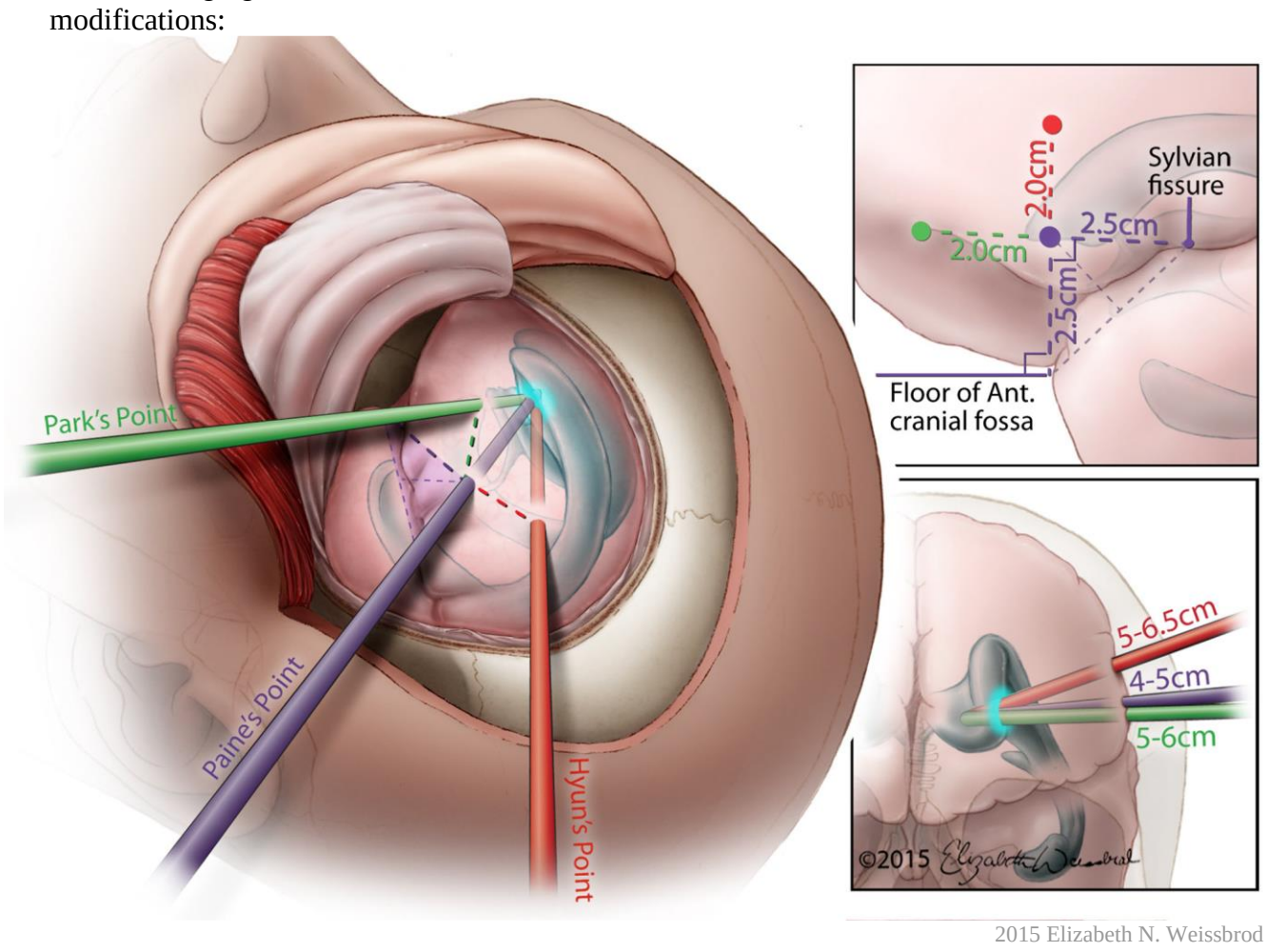
hypotenuse (3.5 cm) is along sylvian fissure (marked by the superficial sylvian vein)
anterior limb starts on dura overlying sphenoid ridge (lateral orbital roof) and goes superiorly 2.5 cm;
posterior limb starts from sylvian fissure and goes anteriorly 2.5 cm;

- catheter enters frontal cortex perpendicularly at vertex of triangle (advance 4-5 cm):





- risk of damaging Broca's area, head of caudate nucleus, and thalamus, thus, there are modifications:



2015 Elizabeth N. Weissbrod

HYUN POINT

- entry point: extend anterior limb of Paine's triangle 2 cm superiorly.
- catheter passed to 5-6 cm depth
- less risk to head of caudate nucleus

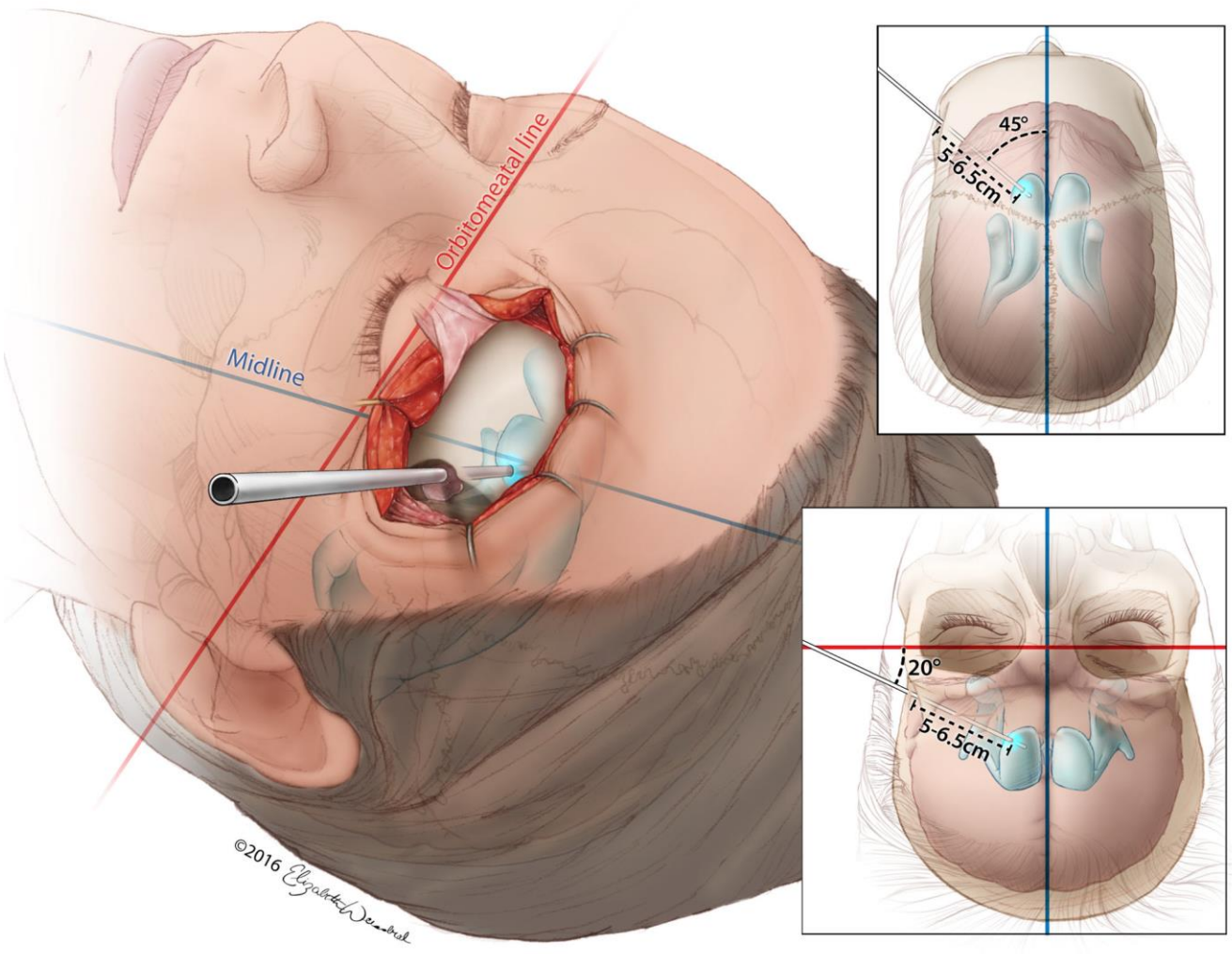
PARK POINT

- entry point: extend posterior limb of Paine's triangle 2 cm anteriorly.
- catheter passed to 5-6 cm depth

MENOSKY'S point - intraoperative ventriculostomy

(during supraorbital craniotomy through eyebrow incision)

- catheter is passed through keyhole burr hole and directed 45º toward the midline and 20 º superior to the orbitomeatal line.
- catheter is passed to a depth of 5-6.5 cm



2015 Elizabeth N. Weissbrod

POSTERIOR (OCCIPITAL) APPROACH

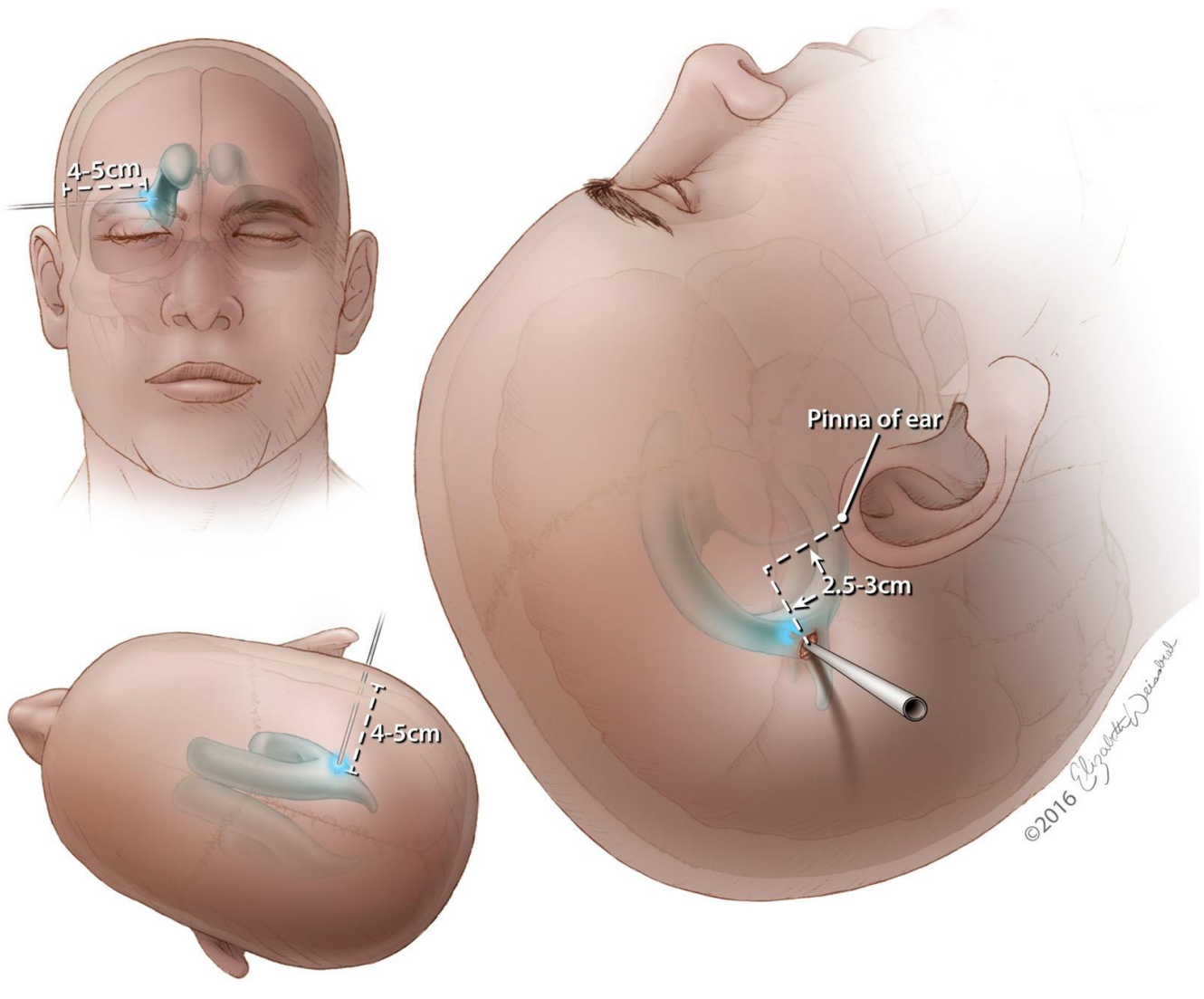
Patient position:

a) supine with ipsilateral shoulder roll and head turned fully toward contralateral shoulder; head of bed can be elevated 15- 20°
b) prone (i.e. suboccipital craniotomy)

KEEN'S POINT

(most common point for tapping cerebral abscesses arising from otitis media)

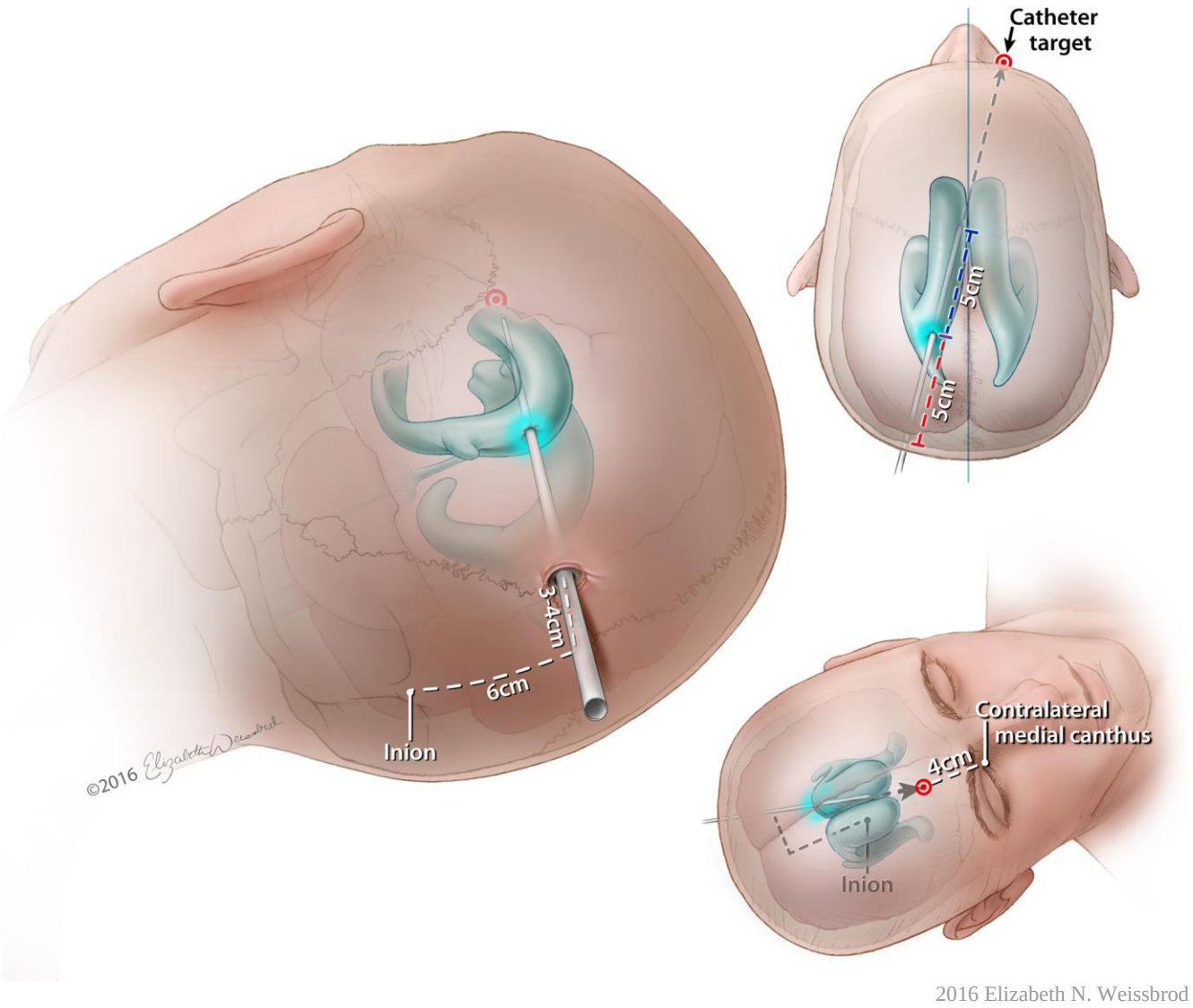
- entry – 2.5-3 cm above and 2.5-3 cm posterior to auricle tip.
- catheter should be aimed in a slight cephalic direction and positioned perpendicular to the temporal lobe cortex.
- pass to a depth of 4-5 cm (trigone of lateral ventricle)



2016 Elizabeth N. Weissbrod

FRAZIER'S POINT

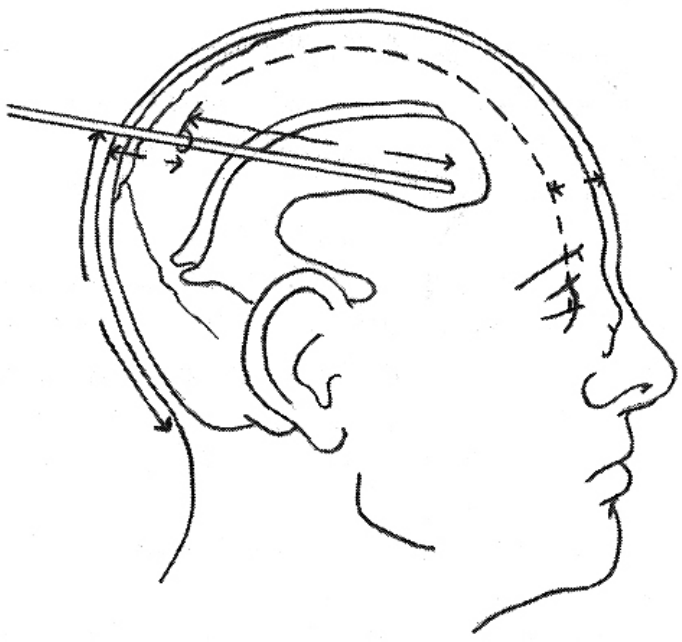
- entry: 6 cm superior to inion and 3- 4 cm lateral to midline (parietal bone 1 cm above lambdoid suture, i.e. flat portion of parietoocciput).
- catheter is aimed medially and superiorly to 4 cm above contralateral medial canthus and passed to initial depth of 5 cm → after CSF is encountered, the catheter stylet is removed, and the catheter is soft-passed an additional 5 cm (total 10 cm), positioning the catheter entirely within the body of the ipsilateral lateral ventricle



2016 Elizabeth N. Weissbrod

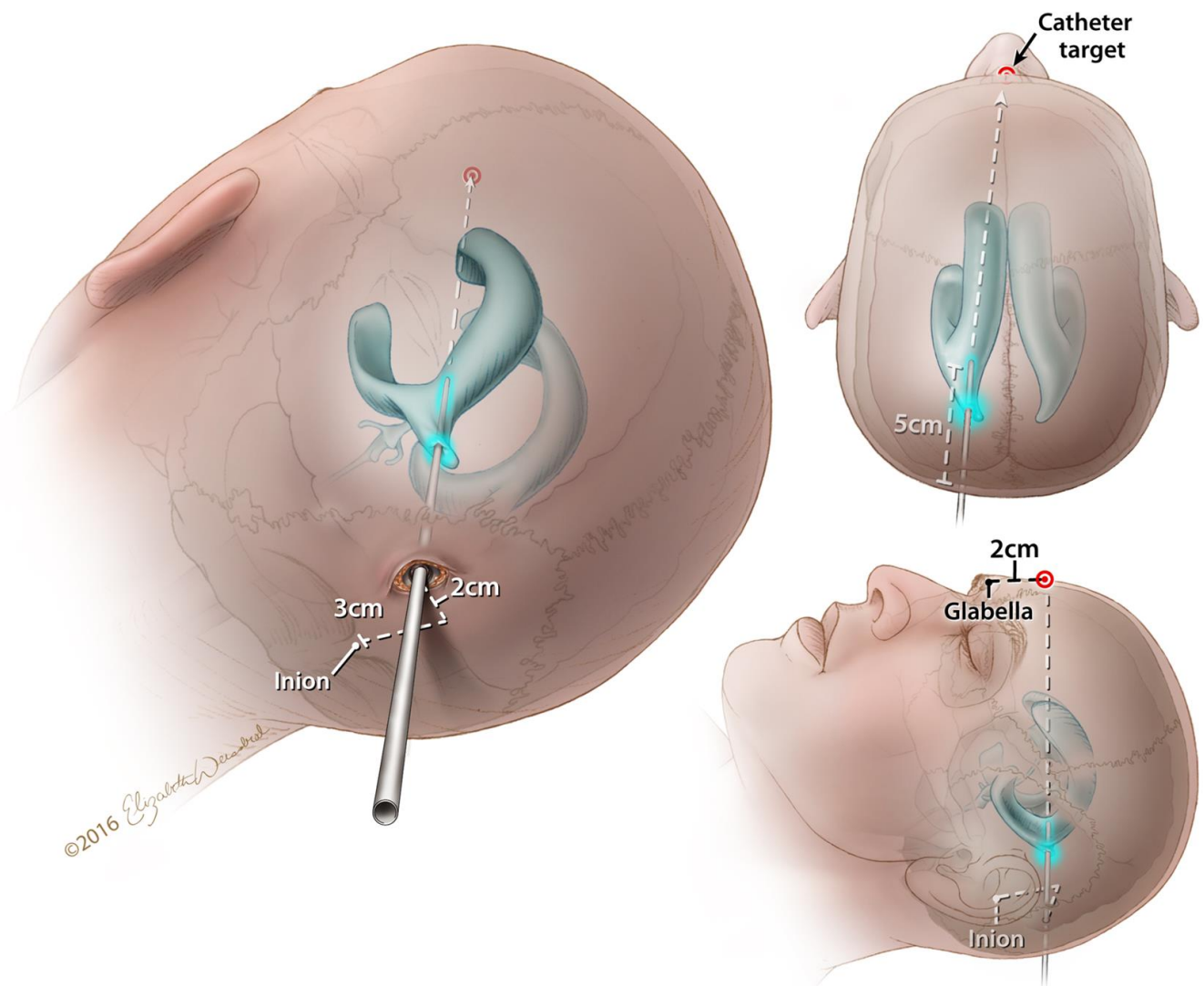
- ventricular catheter with stylet is passed perpendicular to skull base, aiming for middle of forehead above eyebrows, **to depth of 6 cm** → if there is CSF flow, stylet is held still, and catheter alone is passed to depth of 10-12 cm (8 cm for kids) - tip should be in frontal horn just in front of foramen of Monro (to place catheter holes anterior to choroid plexus to prevent hole plugging).

  N.B. stylet to 6 cm, then soft pass!



DANDY'S POINT

- entry: 3 cm superior to inion and 2 cm lateral to midline (occipital bone below lambdoid suture).
- catheter is directed toward 2 cm above glabella and passed 4-5 cm.



2016 Elizabeth N. Weissbrod

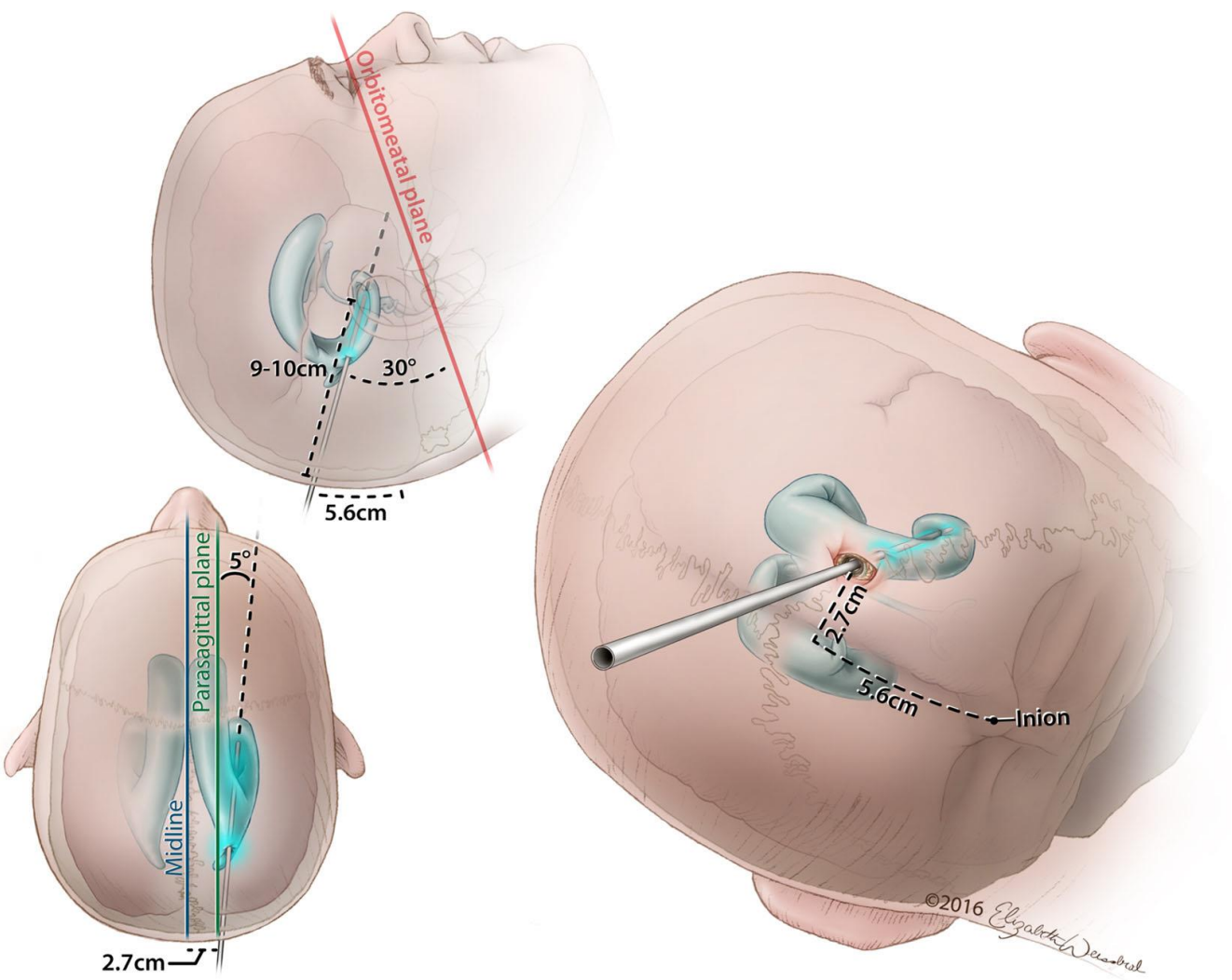
Concerns

- damage to visual fields is a theoretic concern.
- glabella or higher (middle of forehead) and/or more contralateral (to opposite medial canthus) serve as a target in sagittal plane; there is natural tendency to cross midline with this approach, so care should be taken to aim at ipsilateral medial canthus in axial plane (but this may deflect to temporal horn – high chances of choroid plexus obstruction here, plus, temporal horns normally collapse upon successful drainage of hydrocephalus).

SANCHEZ'S POINT

(used to catheterize the temporal horn)

- entry - 5.6 cm above inion and 2.7 cm lateral to midline.
- catheter is directed 5º lateral from parasagittal plane (which is parallel to midline) and 30º inferior toward the orbitomeatal plane.
- CSF should be encountered at 5 cm, and passage of the catheter an additional 4 to 5 cm (total 9-10 cm) should place the tip within temporal horn.



2016 Elizabeth N. Weissbrod

SECURE DRAIN TO SCALP

- using multiple interrupted sutures (don't use silk – very proinflammatory).
- adapter is secured to catheter using **3.0 silk suture**; incision is sutured and catheter secured to scalp in at least three places using **3.0 nylon** (purse string 3.0 nylon suture at catheter exit site to prevent CSF leak).
- for unreliable patients – make pigtail loop with catheter on scalp – if patient pulls on it, it will clamp the catheter but will not pull it out.
- suture connector hub to scalp directly.
- sterile dressing (Tegaderm).

FURTHER MAINTENANCE, DRAINAGE HEIGHT

Units

- EVD monitoring display shows in mmHg.
- all studies done in mmHg.
- most attendings at VCU (except Dr. Simon) use cmH_2O – because, if patient needs shunt, valve settings are in cmH_2O.

According to pathology

Do not overdrain! Clamp EVD while positioning in OR (e.g. prone)

SAH (unsecured aneurysm) – drain at 10 (if lower – transmural pressure gradient↑ in aneurysm wall may provoke rebleeding).
SAH (secured aneurysm) – drain at 0.
Trauma – "20 pop down to 10" – i.e. monitor ICP and, if ICP goes above 20, open and drain at 10 until ICP drops.
IVH – may drain at 0 to encourage CSF clearance.
posterior fossa mass – drain at 15-20 (to prevent upward herniation – safer to keep it clamped); (some say in pediatric patients – 25).

CSF output relevance to challenging

When **< 100/8hr shift** – may start challenging (i.e. rising); don't challenge EVD until > 6-7 days post SAH
When **< 100/24hr** – may clamp → CT after 24 hours – if ventricles of normal size (can be slightly larger than when EVD was open), may D/C EVD.

Dr. JRC challenges: 0 → 10 → 20

REPLACEMENT OF CATHETER

- use stylet (soft pass may fail).

Dr. Villanueva – if within 24 hrs, use same tract; if after 24 hrs, drill new skull hole.

COMPLICATIONS

1. **Overdrainage**
   Integra LimiTorr™ Volume Limiting External CSF Drainage and Monitoring System - used for ventricular or lumbar catheter - volume limiting valve mechanism reduces chance of excessive CSF drainage by halting drainage when pre-determined volume (20 mL or 30mL) is reached.
2. **Obstruction** – check whole tubing for kinks, etc. Flush with sterile saline distally (may also flush proximally very gently). If no success → CT.
3. **Infection** – risk factors: ↑duration of EVD, bloody CSF, frequent flushes
4. **Hemorrhage** (7%, clinically significant 0.8%)

Bauer DF "Meta-analysis of hemorrhagic complications from ventriculostomy placement by neurosurgeons." Neurosurgery. 2011 Aug;69(2):255-60