Clinical Guidance

Insertion and Management of Spinal Drains in Adult Critical Care

Summary
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GUIDELINES FOR THE INSERTION AND MANAGEMENT OF SPINAL DRAINS.

PARAPLEGIA IS A CATASTRPOHIC COMPLICATION OF THORACOABDOMINAL ANEURYSM SURGERY AND THORACIC AORTIC STENTING.

ANY DETERIORATION IN NEUROLOGICAL STATE SHOULD BE TREATED AS A MEDICAL EMERGENCY AND SHOULD BE REPORTED TO THE MEDICAL TEAM AND NURSE IN CHARGE IMMEDIATELY. DELAY IN DETECTION OR TREATMENT CAN RESULT IN PERMANENT NEUROLOGICAL DAMAGE.

*****ONLY TRAINED AND EXPERIENCED NURSING STAFF SHOULD LOOK AFTER THIS PATIENT GROUP.*****

Why do we have spinal drains?

Spinal drains are commonly used in Thoracoabdominal Aortic Aneurysm repair surgery, as frequently blood supply to the spinal cord can be compromised during cross clamping and as a result of intercostal arteries ligation (which feed the anterior spinal artery – the most important vessel supplying the spinal cord). They are also being used with increasing frequency in patients undergoing Endovascular Aortic Aneurysm Repairs (EVAARs) where blood flow in intercostal and upper lumber arteries may be compromised as a result of stent deployment.

The use of spinal drains has shown a reduction in the incidence of paraplegia from 13% to 2.6% [1], and can prevent 1 in 20 neurological deficits in all types of aneurysm and 1 in 5 deficits in type II aneurysms [2].

[1] Coselli JA, LeMaire SA, K□ksoy C et al. Cerebrospinal fluid drainage reduces paraplegia after thoracoabdominal aortic aneurysm repair: results of a randomized clinical trial. *J Vasc Surg* 2002; **35**(4): 631-9

[2] Safi HJ, Miller CC 3rd, Huynh TT et al. Distal aortic perfusion and cerebrospinal fluid drainage for thoracoabdominal and descending thoracic aortic repair. Ann Surg 2003; **238**(3): 372-81

Risk factors for paraplegia:

High Risk:

- Open thoracic or thoracoabdominal aortic repairs
- Extent of stent coverage – full descending thoracic or thoracoabdominal aorta (Crawford Type I or II)
- Previous distal Abdominal Aortic Aneurysm (AAA) repair
- Left subclavian artery coverage
- Occlusive disease in the iliac artery
- Prolonged aortic cross-clamp time

Intermediate or Low Risk

- Descending or proximal thoracic aortic stents
- Type B dissections

Occasionally some major spinal surgery, head-neck surgery and neurolosurgical indications may necessitate the insertion of spinal drain.

Pathophysiology:

Cross clamping the thoracic aorta leads to increased proximal aortic pressure, central venous pressure (CVP) and CSF Pressure (CSFP) and production, with reduced blood flow and perfusion to areas distal to the cross clamp.

Spinal Cord Perfusion Pressure = MAP – (CSFP or CVP)

Inserting a spinal drain and diverting the CSF to an external system reduces the pressure of the CSF and allows improved blood flow through the blood vessels that supply the spinal cord. However, the importance of keeping the MAP higher than normal should be remembered. If inserting a spinal drain, a central line should also be inserted to allow administration of vasopressors to allow increased MAP target on the critical care unit.

INSERTION OF A SPINAL DRAIN

A video showing spinal drain insertion can be found at **https://youtu.be/ytP1KgsV2ik**

1. PRELIMINARIES:

a) Detailed ***discussion between surgeon and anaesthetist*** on real value of spinal drain …versus *increase MAP* (SCP= MAP- CSF)- depending on level of surgery and coverage by the thoracic graft/stent, previous aortic stents/grafts & depending on how soon patient can be neurologically assessed post-operatively (i.e. If the patient is likely to be ventilated)

b) ***Consent*** –documented: Common: PPDH, 1-2%, failure. Rare : 1 in 1000 nerve damage, paraplegia, meningitis, intra-cranial bleeds.

c) Rule out contraindications:

   i. Absolute: coagulopathy, infection at site, raised ICP/space occupying lesion, unwilling/uncooperative patient

   ii. Relatives : Sepsis, antiplatelet therapy, inexperienced operator.

d) Document baseline neurology, current clotting and anticoagulant status

e) Strict asepsis best achieved in theatre settings

f) Post-operative care must be in a High Dependency Area, with a central line to allow use of vasopressors to increase MAP if necessary.

2. EQUIPMENT CHECK – available in OIR/Hybrid Anaesthetic Room

a) Spinal Drain x 2 (Integrated^{R})

b) Compatible spinal drain system (packed separately) – Medtronic^{R} (DM lumbar Drainage Kit)/ Integra (avoid Codman kit).

c) Epidural pack – for Loss-Of-Resistance (LOR) syringe

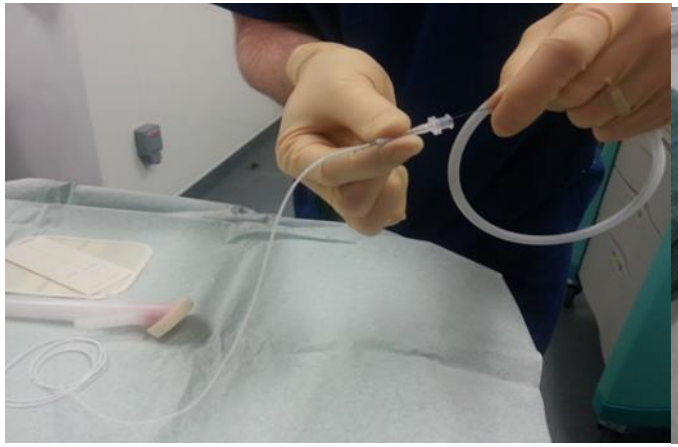
d) Other: Suture 2.0 silk, Blade, Sterile Saline, Local anaesthetic

3. PATIENT POSITION

a) Lateral Decubitus with legs flexed preferred- reduces risk of excessive CSF drainage
b) Asleep vs Awake +/- sedation (pro-con is as per epidural, both are practised in this hospital, in postop setting awake is more likely)
c) Insertion Level ideally below L2/L3

4. PREPARATION

a) Full Aseptic Technique:
   I. Prep and drape as per local policy for neuro-axial anaesthesia
b) Skilled assistant essential
c) Familiarise yourself with equipment:
   I. 14 G Tuohy needle – metal, wingless and no markings
   II. Spinal drain catheter – soft silicone (silastic) tube with multiple holes proximal to the tip and black markings
   III. Standard epidural pack – LOR Syringe
d) Imperative to prime the spinal catheter with sterile 0.9% NaCl **(for lubrication)** before introducing guidewire **(stiffens the catheter)** before insertion
e) Do not feed the guidewire to the end, leave 4-5 cm of catheter tip free of guidewire
f) Level of insertion as per Spinal, below L2/L3 - ideally L4/5 (to avoid spinal cord injury)



5. INSERTING SPINAL DRAIN

a) Advance 14G Tuohy needle LOR epidural space).
b) Remove syringe and carefully advance Tuohy needle-1mm at a time. A typical "give" may not always be felt once the subarachnoid space is reached. Sometimes you may hit the posterior longitudinal ligament and may only get CSF while withdrawing the needle.
c) Once CSF starts draining, replace the syringe on the end of the Tuohy needle to avoid excessive CSF loss.
d) Pass the spinal catheter through the Tuohy needle.

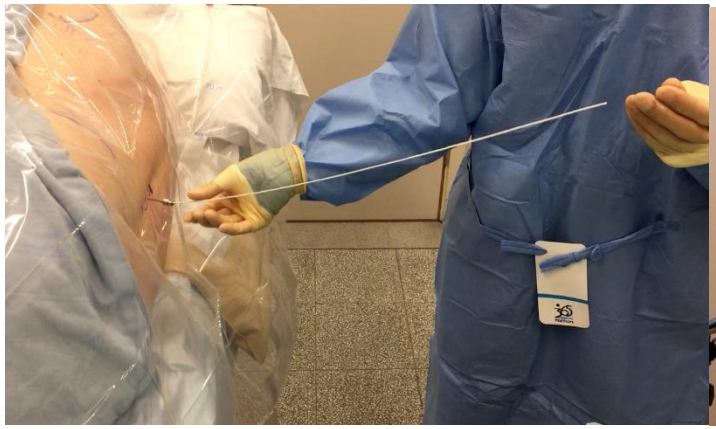
NOTE: Markers on the Integrated [R] catheter begin at 10 cm! i.e. 10cm marker is at 20 cm on the catheter. The markings are not circumferential, so be careful when you withdraw the catheter after insertion.

6. WIRE and NEEDLE REMOVAL – 2 techniques

a) Technique 1 – Withdraw wire as you advance catheter through Tuohy. Once the wire is out, remove Tuohy (in order to avoid wire going into subarachnoid space where it can cause the catheter to shear)
b) Technique 2 – Advance catheter with wire in, then remove Tuohy, then remove wire. (This avoids catheter potentially shearing on Tuohy needle)

NOTE: Check for adequate flow of CSF through the catheter. CSF may occasionally be blood t inged – this should clear with continued drainage (see Hints and Tips section)

NOTE: If resistance felt with either method DO NOT USE EXCESSIVE FORCE This may result in a fractured catheter. If resistance felt - pull wire, catheter and needle out all together and start again.



7. POST INSERTION CARE

a) Secure spinal catheter with occlusive dressing. Suture desirable but take care not to put a stitch through the catheter!
b) Tape catheter to skin so that it comes out to the side of the patient
c) External drainage system should be flushed with saline and fully deaired (removing airlocks) aseptically
d) Connect the drain to the external drainage system- refer to intranet guidance
e) Zero to the reference point marked on patient side at same level as insertion
f) Make sure CSF flows from the catheter into the drainage system
g) *Patient should be no more than 30 degrees head up (except short periods of time) to avoid excessive CSF drainage.*

9. BLOODY TAPS: Can be through the needle or through the catheter.

Though the needle: Don't panic. Try and analyse the situation: Is the needle superficial or with in the vertebral canal (depending on the depth and angulation?

a) Superficial bleed is likely to a muscular vessel. In this situation withdraw needle, apply pressure and continue with insertion in the same space.
b) Bleeding with in the vertebral canal could be epidural vein (if only blood) or spinal vessel (if blood with CSF). Blood tingein CSF is not uncommon and should clearly rapidly. But if frank blood appears (in either situations– epidural vein or spinal vessel trauma) try a different space (if experienced, if not call for help).
c) Delay heparin administration for 60-minutes and inform the surgical team.
d) If you get traumatic tap again, consider re-scheduling the case.

Bleeding Through the Catheter:

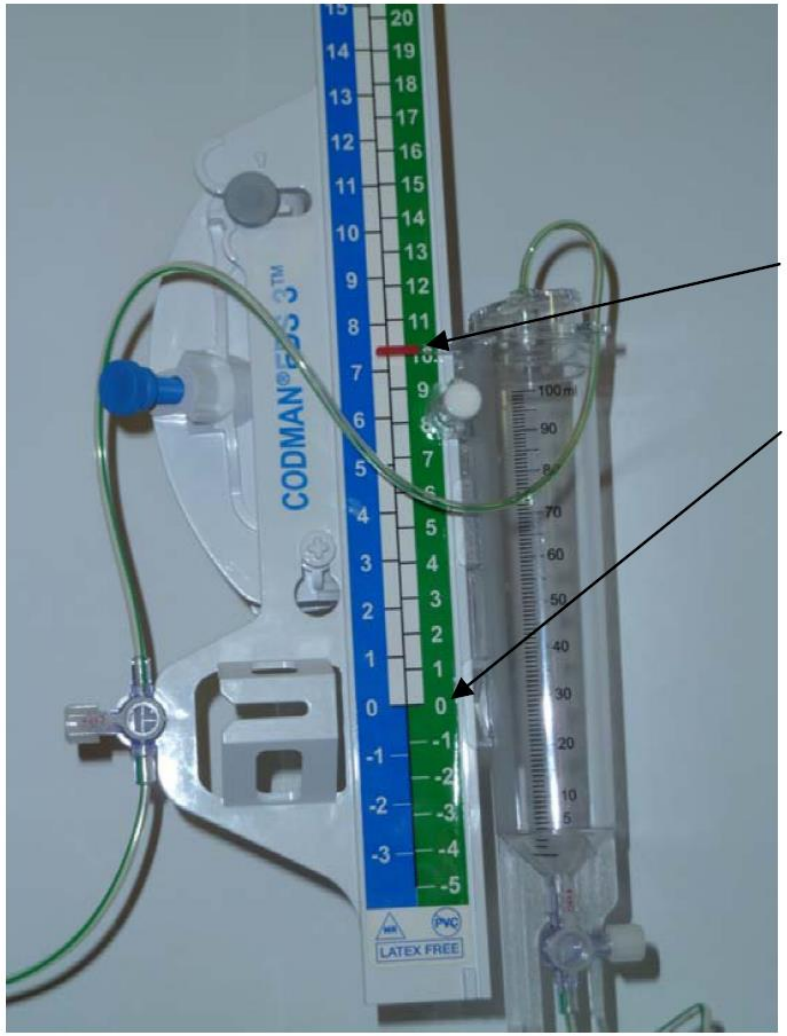
During Insertion (Pre-Heparinisation): Let CSF drip.

a) If it clears, carry on with the procedure but delay heparin for at least 60 min.
b) If it does not clear, consider rescheduling the procedure.

During Procedure (Post-Heparinisation):

a) Post-heparin, you are committed to the procedure.
b) Continue drainage. Raise the CSF drainage pressure if necessary. This would reduce the pressure gradient for bleeding.
c) Inform surgeon, complete stent deployments ASAP & reverse heparin. Aggressively correct any coagulopathy.
d) Wake the patient and assess neurology as early as possible.
e) If any focal neurology present, consider urgent MRI.

Arrival of patient into Critical Care Unit:



Picture 1

Green scale = cm H2O

Set Arrow to 10 cm H2O

Zero on scale should be set at level of point of insertion (lower lumbar spine)

Action	Rationale
Ensure patient is positioned between supine and a maximum of 30 degrees	Sitting higher than this can cause severe headaches as the drainage of CSF reduces the volume that supports the brain and can lead to subdural haemorrhage, brain herniation and coning in severe cases.
Ensure that the drain is zeroed at the entry point of the catheter, i.e. the lower lumbar spine. Rarely a spinal drain may be placed at another site following another form of surgery. If so, please confirm with a surgeon / anaesthetist at what point the spinal drain should be zeroed.	To ensure all drainage has the same reference point and to therefore avoid uncontrolled drainage of CSF
Establish at what height the drain should be set - 10cm on the green scale, unless otherwise specified by the medical/surgical team. (See Picture 1).	Setting the drain too low can result in excessive drainage of CSF, severe headaches and subdural haemorrhage. Setting the drain too high can result in too little drainage of CSF resulting in decreased blood supply to the spinal cord and potential paraplegia.
Check the insertion site shows no sign of inflammation or leakage and that the dressing is intact.	To detect as early as possible any signs of infection or possible routes for infection as bacteria entering the CSF can cause life threatening complications.

Ensure the catheter is connected and is not kinked.	A disconnected catheter leads to uncontrolled loss of CSF, the risk of subdural haemorrhage and is a source of infection. A kinked catheter will prevent drainage of CSF leading to raised pressure in the subarachnoid space that will compromise the blood flow to the spinal cord and could result in paraplegia.
Ensure the 3-way tap on the CSF circuit is sealed off with tape and a 'Do not use' notice is applied.	This is the sampling port on the line and should only be used by medical staff adhering to strict asepsis as the risks of cerebral infection are substantial.
Check that CSF is dripping into the chamber.	This demonstrates that the whole circuit is patent.
On admission lighten the sedation and make baseline assessment of the patient's neurological status including GCS and especially lower limb function. Sedation should be short acting (propofol and alfentanil for example) and **stopped hourly** to allow accurate assessment.	To ascertain any deficits on arrival and to inform medical staff immediately if there are. Short acting sedatives allow rapid assessment of limb function, necessary when assessing hourly.

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Maintenance

Action	Rationale
In general ensure MAPs of > 90mmHg. Sometimes MAPs of 70-80mmHg are prescribed by the surgical team.	The aim is to deliver an adequate blood pressure to ensure perfusion of the spinal cord. Lower MAPs are considered if there is an increased risk of bleeding into the drains.
Perform hourly sedation hold and neurological assessment.	To permit early detection of deficits. Alert medical team and nurse-in-charge immediately of any sensory or motor deterioration, especially in the lower limbs.
Ensure hourly that the drain is accurately zeroed to the entry site of the spinal drain and set to the correct height; unless otherwise specified by medical team at 10 cm H_2O.	To avoid excessive or reduced drainage of CSF, compromising neurological function.
Check hourly that the catheter is un-kinked, patent and that the CSF is draining into the reservoir.	This indicates that the system is patent.
Record the hourly drainage. Having done so, to empty the reservoir, turn the stopcock, to an "off" position, (picture 2), unclamp the two clamps, (picture 3), below	CSF is produced in the cerebral ventricles at about 20 mls/hour. If the drainage is persistently more than this there is a risk of severe complications. Go to TROUBLESHOOTING. If there is no drainage go to

the reservoir and allow the CSF to drain. When the reservoir is empty, clamp the two clamps, (picture 4) and return the stopcock to an "on" position, (picture 5).

Check for fresh blood in the CSF.

On turning or suctioning the airway, turn the stopcock to the "off" position. Having finished turning, realign the system and reopen the stopcock. Having finished suctioning the airway, reopen stopcock.

On turning, examine the spinal drain entry site for signs of infection or leakage. Redress with sterile transparent dressing such as Tegaderm in a sterile fashion and inform medical staff if signs are present.

The drainage bag should only be changed when the bag is full and should be done in a strictly aseptic manner. The clamps should be applied, diagram 1 point 2, and stopcock turned to off. The nurse should wash hands, put on gown and sterile gloves and, using a dressing pack, should remove the old bag, clean the ports with Chlorhexidine 2% (allow to fully dry) and attach the new bag

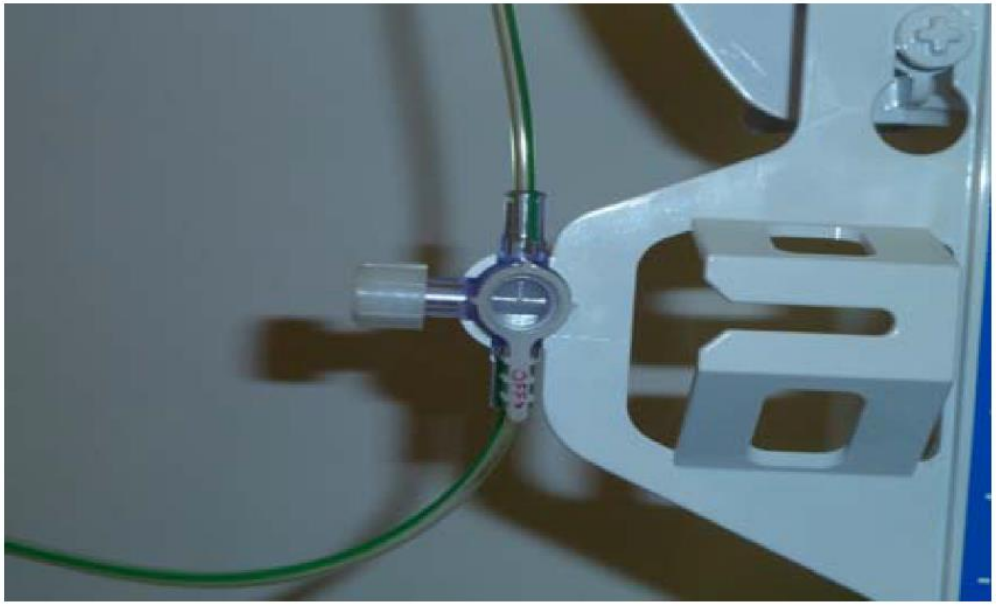
TROUBLESHOOTING.
Turning the stopcock to an "off" position prevents a siphoning effect when draining the reservoir.

Inform medical team and nurse-in-charge immediately. Do not clamp the drain system as the blood may clot permanently blocking the drain. See TROUBLESHOOTING.

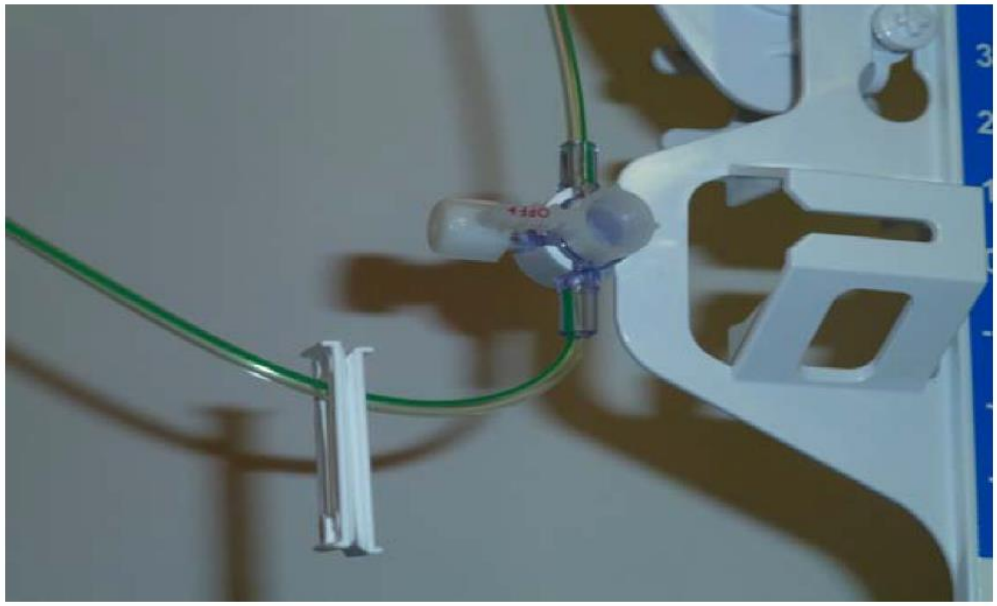
To prevent inadvertent flow through raised intra-abdominal pressure. The change in position may warrant a re-zeroing of the system. Failure to do so can cause an inappropriate flow of CSF. Reopening the stopcock allows the pressure in the spinal column to remain as it is set - usually 10 cm.

Infection in the CSF and ultimately the brain can be fatal. Prompt appropriate medical intervention is necessary to prevent this.

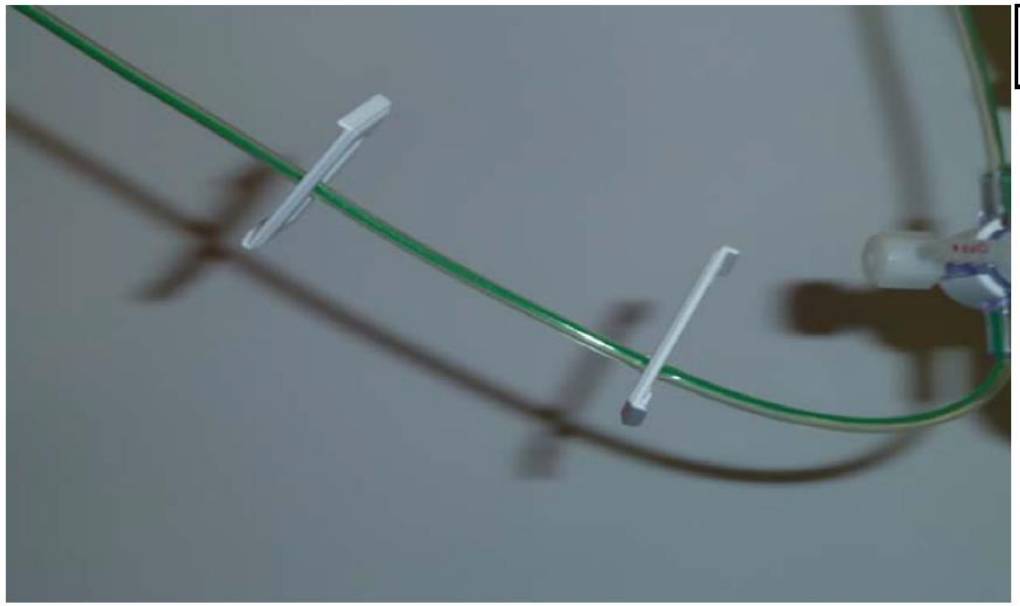
The clamps are applied and the stopcock to prevent inadvertent siphoning and drainage of CSF.
Strict asepsis is used to prevent infection into the CSF and brain.



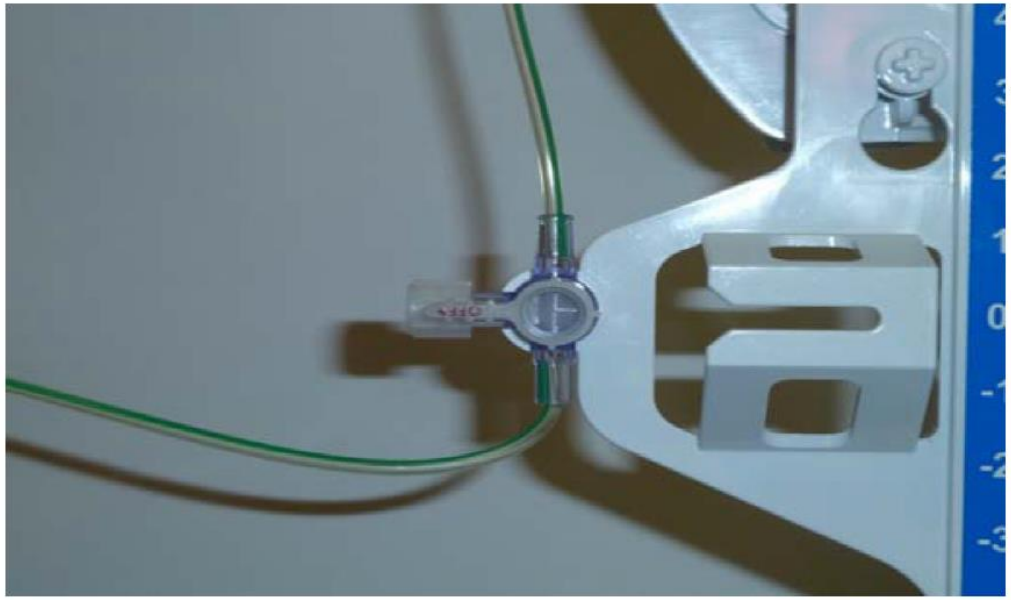
Picture 2. Stopcock in "Closed" position.



Picture 3. Clamps in “Open” position.



Picture 4. Clamps in “Closed” position.



Picture 5. Stopcock in "Open" position.

Removal of drain - 72 hours post-op

Action	Rationale
Assess patient's distal neurological status and record in the notes. Following medical decision to remove the spinal drain, the drain is clamped for at least 6 hours prior to final removal. Continue to assess for signs of neurological deterioration every hour.	To ascertain a baseline. The clamping allows the CSF to build up to its normal pressure around the spinal cord. If there is neurological deterioration the clamp can be taken off and the pressure reduced to allow better blood flow to the limbs that are deteriorating. If there is no deterioration, the drain can be removed.
Ensure clotting is normal and platelet count is > 50. Wait at least 12 hours post administration of low molecular weight heparin and at least 4 hours after unfractionated heparin. Recommence thromboprophylaxis 4 hours after removal.	Extended clotting risks bleeding into the CSF and may result in increased pressure in the spinal column, limb deterioration and impaired CSF flow around the brain.
Place patient on their side. Wash hands and put on sterile gloves. Clean the area with Chlorhexidine 2% (allow to fully dry). Pull the drain with a long steady motion, ensuring that on removal the tip is intact and fenestrations or drainage holes are present. If there is resistance keep the drain insitu and inform medical staff immediately. Apply an occlusive sterile dressing such as Tegaderm	To ensure sterility. A smooth motion is less likely to cause a break in the drain. If the fenestrated tip is not present it has to be assumed to be *in vivo.* It is an infection risk. The drain is kept to verify the absence of the tip and so that it can be kept as part of a clinical incident investigation. To maintain asepsis.

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Troubleshooting

1. Neurological deterioration

If there is any change in sensory or motor function, inform medical staff and nurse-in-charge immediately.

Check that the system is correctly aligned, set at the prescribed level and that CSF is draining. Ensure there are no kinks or blockages in the line or disconnection of the system.
Ensure the spinal catheter is still in situ. Ensure MAPs are > 90mmHg, (unless lower MAPs have been agreed by the surgical and ICU teams-in which case adhere to them.) The medical team may consider CT/MRI.

Any deterioration should be treated as a medical emergency.

When there is no drainage in a one-hour period: Check drain is zeroed to the entry site of the spinal catheter.

2.No flow

When there is no drainage in a one hour period:
Check drain is zeroed to the entry site of the spinal catheter.

To ensure that desired settings are adhered to so that flow is possible.

Ensure that the drain is set at the correct level- usually 10cm.

10 cm H_2O will allow the pressure in the CSF to reach only 10 cm H_2O before it will start to flow. This should allow a sufficient blood flow to the spinal cord.

Check that the line is free from kinks.
If kinked, un-kink it.
Check that the drain is unclamped and "on" to the patient

A kinked, "off" or clamped line will result in raised pressure in the spinal column, preventing adequate blood supply to the spinal cord.

After 5 minutes, if there is no drainage lower to 5 cm H_2O.

If there **is** drainage at 5 cm H_2O, return to 10 cm H_2O.

If there is no drainage in 5 minutes at 5 cmH2O, inform ICU medical staff, the appropriate Vascular team and Consultant Anaesthetist **immediately.**
The drain can, rarely, be set to 0, but only after discussion with the consultant.

Lowering the drain will allow CSF to flow when it reaches a lower pressure, assuming the system is patent. If there is flow at the lower level, return to 10 cmH_2O where flow will occur when the pressure in the spinal column rises to 10 cmH_2O again.

Delay in appropriate treatment may result in permanent paraplegia. MRI or CT may be needed as well as re-siting of the spinal drain.

3. Excessive flow

If CSF flow is persistently high, i.e. > 25ml/hr for 2 consecutive hours; Check the level is aligned correctly, usually 10 cm H_2O
Monitor neurological status and check for signs of headache.
Inform medical staff and nurse-in-charge.
The drain may be raised to 12 cm H_2O after discussion with the ICU/Vascular team.
Observe for change in neurology.
Do not clamp system.

CSF is produced at 20 mls/hr, so drainage of > 20mls/hr constitutes a net decrease in the volume surrounding and supporting the brain/spinal cord and can lead to severe headaches and sub-dural haematomas.
Excessive flow will occur if the drain is set too low. Raising the drain may slow output of CSF, but has to be balanced against the risk of increasing the pressure in the spinal column and causing neurological deficit.

4. CSF leaking from drain insertion site

Remove dressing and examine the site.
If no evidence of a leak, clean with Chlorhexidine 2% (allow to fully dry) and redress entry site with transparent occlusive dressing.
If leaking, inform medical team and nurse-in-charge. Apply transparent occlusive dressing or sterile stoma collection bag.
If drain has already been removed, cover with transparent occlusive dressing or sterile stoma collecting bag.

Transparent, occlusive dressings and sterile stoma bags allow us to ascertain how much is leaking out.

5. Break in the system

If there is a disconnection in the system, clamp off both ends, clean them with Chlorhexidine 2 %, wearing sterile gloves, wrap with sterile gauze and secure with sterile dressing such as Tegaderm. Inform the medical team and Consultant Anaesthetist. A decision will be made at Consultant level about the need to replace the drain.	Clamping off the drain proximally will prevent the free flowing drainage of CSF. Once the circuit is broken, there is a risk that bacteria will enter the CSF and meningitis and further brain infection are possible. The Consultant team will decide on the relative risks of insertion of a new spinal catheter and reconnection of the disconnected drain.

6. Visible blockage

If visible blockage is seen, inform medical staff. **The blockage is not to be flushed towards the patient.**	Flushing a blockage may block the drainage of CSF out of sight. If it can be, any blockage will have to be carefully aspirated by medical staff.

7. Visible blood

If blood is seen on admission from theatre, consult the accompanying anaesthetist. If there is a new presentation of fresh blood inform the medical staff and nurse-in-charge immediately. Do not clamp the drainage system	It is not uncommon to see blood staining of CSF due to microvascular bleeding and coagulopathy, after TAAR. Coagulation will need to be corrected. The blood may also be the result of the traumatic insertion of drain. There could have been a subarachnoid bleed which can cause a sudden increase in pressure in the spinal column or block the drain, both of which can cause raised ICP, neurological deterioration and death. A CT or MRI may have to be ordered after discussion with the Vascular team and ICU Consultants and possible neurosurgical intervention.

8. Infection

Monitor for signs of infection; Redness, swelling, leakage at entry site, pyrexia, stiff neck, headache, photophobia, nausea and vomiting, confusion and agitation. Inform medical staff and nurse-in-charge immediately.	Infection as a result of CSF drain can be potentially fatal and needs urgent medical attention. Medical staff may need to take and send CSF sample from drain for culture or take lumbar puncture sample if drain already removed.

ANY DETERIORATION IN NEUROLOGICAL STATE SHOULD BE TREATED AS A MEDICAL EMERGENCY AND REPORTED TO THE MEDICAL TEAM AND NURSE IN CHARGE IMMEDIATELY.

Abbreviations:

CM H2O= centimetres of water

CVP= central venous pressure

CSF= Cerebrospinal Fluid

CSFP= cerebrospinal fluid pressure

MAP= Mean arterial pressure

SCPP= spinal cord perfusion pressure

List of Consultant Anaesthetists to call for advice (number from switchboard):

1. Amit Chawla
2. Dan Taylor
3. Madhu Rao
4. Heena Bidd
5. Jason Scott
6. Sohini Sengupta
7. Nishant Sadana

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