East of England Neonatal ODN
(Hosted by Cambridge University Hospitals)

EAST OF ENGLAND NEONATAL NEUROPROTECTION GUIDELINES
POLICY ON MANAGEMENT OF TEMPORARY DEVICE IN POST- HAEMORRHAGIC VENTRICULAR DILATATION (PHVD)

CONTENTS

NB. Refer guidelines on management of PHVD and neurosurgical referral via Orion

POLICY ON MANAGEMENT OF VENTRICULAR RESERVOIR IN POST HAEMORRHAGIC VENTRICULAR DILATATION

1.0 INTRODUCTION

Progressive PHVD is associated with a three to four-fold increase in neurodevelopmental delay. Literature suggests early intervention in PHVD is associated with better neurodevelopmental outcome (de Vries et al., 2002). The treatment of PHVD with a permanent shunt in preterm infant is difficult due to technical factors, risk of abdominal sepsis and associated co-morbidities e.g. sepsis, increased risk of NEC (Lam et al., 2009, Fountain et al., 2011). A permanent shunt in preterm infants is associated with revision and blockage of shunt. Temporary treatment commonly used for diversion of CSF in the management of PHVD is insertion of a ventricular access device (VAD) and ventricular sub-galeal shunt (VSGS), which may reduce the morbidity and mortality associated with PHVD (Mazzola et al, 2014). The details of temporary treatment are given below.

2.0 TEMPORARY SHUNTS

2.1 Indications for Temporary Treatment

a) Ventricular index on cranial ultrasound approaching to ≥97+4mm, AHW ≥6mm, TOD ≥ 25mm.
b) Lumbar punctures unable to prevent further increase in VI.
c) Increasing head circumference.
d) Symptoms of increased intracranial pressure.

The temporary treatments of PHVD are:

a) VSGS placement, in which the CSF is shunted into the sub-galeal space of the scalp and absorbed into the bloodstream.
b) Ventricular reservoir placement for intermittent tapping.

2.2 Ventricular access device (ventricular reservoir) (Ellenbogen et al, 2016)

The procedure of placement of a ventricular reservoir is technically simpler and involves insertion of a subcutaneous reservoir connected to a ventricular catheter for percutaneous CSF tapping, which is undertaken at regular intervals. The common ventricular access devices are Ommaya's and Rickman's reservoir. The ventricular reservoir is preferred method of CSF removal compared to Lumbar puncture.

The advantage of ventricular reservoir is that it yields adequate amount of CSF drainage over lumbar puncture.

2.2.1 Complications of using a reservoir (Ellenbogen et al., 2010, Tenbrock et al., 2003)

a) CSF leakage.
b) Infection, and possible skin breakdown.
c) Blockage of catheter.
d) Migration of catheter.
e) Over-drainage leading to slit like ventricles.
f) Hyponatremia due to frequent CSF tapping.

The use of rigorous infection control protocols for CSF tapping minimises the infection rate for VADs.

2.2.2 Indications for ventricular tapping

a) Ventricular index remaining on $\geq 97^{th}$+4mm on Levene's chart.
b) Persistent increasing head circumference.
c) Frequency of tapping after insertion of reservoir will be twice a week with the aim to bring VI <97+4mm.

2.3 Ventricular Sub-Galeal Shunt

2.3.1 Benefits of VSGS compare to Ventricular reservoir (Wellons et al., 2017)

a) VSGS does not require intermittent transcutaneous access thereby decreasing the risk of skin contamination and device infection associated with reservoir.

b) VSGS maintains a closed system in which fluid and electrolytes are not lost as seen with intermittent tapping in VAD, thereby reducing the need for replacement of fluid.

c) The mild backpressure from the sub-galeal space maintains a challenging force for the CSF absorptive pathways and potentially restores normal function of CSF absorption.

d) Earlier discharge home has been reported with VSGS.

2.3.2 Complications of the VSGS

(Christian et al., 2016, and El-Dib M et al, 2020, Appendix 1b)

a) Scarring of the sub-galeal pocket results in inadequate drainage.

b) Blockage of catheter.

c) Slippage or migration of catheter.

d) CSF leakage.

e) Infection and failure rates (Fountain et al, 2016).

f) Over-drainage leading to slit like ventricles (rare with VSGS).

g) Loculated hydrocephalus.

2.3.3 Monitoring of VSGS

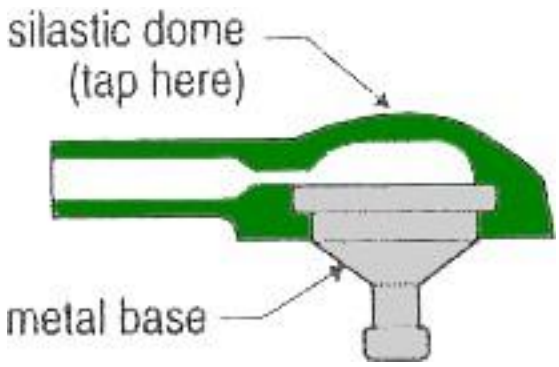
a) Ensure the sub-galeal pouch is adequate in size, which can be seen as swelling at the site of sub-galeal catheter. This will provide information on adequate CSF drainage.

b) Ensure head growth is adequate with monitoring head circumference regularly.

c) Initially, monitor ventricular indices weekly and more frequently if any concerns. This will provide information on adequate functioning of VSGS.

d) Suspect malfunctioning of shunt if persistent increasing VI / head circumference and the size of pocket small, indicating scarring resulting in inadequate drainage of CSF.

2.4 Procedure for tapping through ventricular access device (Follow local trust infection control asepsis policy)



Equipment

- Chlorhexidine 0.5% skin preparation solution.
- 25-gauge butterfly needle.
- Standard infant lumbar puncture set.
- Sterile drapes to allow for maintenance of a sterile field.

Precautions

- Gradual removal of CSF to prevent sudden shift of fluid. Recommended removal of CSF 10ml/kg over 10 min-15 min.
- Monitor and correct serum electrolytes every other day if more than 10ml/Kg of CSF drained daily.
- If skin breakdown occurs, select insertion site away from broken area.

Technique

- Consider the use of Sucrose for analgesia if the baby meets the criteria.
- Place the infant with head in neutral position in anticipation of a 20 to 25-minute procedure.
- Cut any long hair that interferes with the surgical area but do not shave operative area.
- Wearing sterile gloves, clean skin with chlorhexidine 0.5% over the reservoir and a surrounding circle of skin with a diameter of 4cm.
- Position sterile drape to maintain a sterile field.

- Insert butterfly needle through skin just into reservoir bladder.
    - Select an insertion site different from the one most recently used.
    - Angle needle at 30 to 45 degrees from the skin.
- Drain 10ml-20 ml/kg of CSF (no more than 30ml). This should be done over 10 -20 minutes by free drainage. Send CSF for culture, cell count, glucose and protein.
- Remove needle and hold firm pressure for 2 minutes or until CSF leakage from skin stops.
- Follow up cranial ultrasound for monitoring VI.

2.5 Treatment of complications of temporary shunt (Appendix 1b)

a) CSF microscopy is positive, and infant is symptomatic, then treat with antibiotics as per local sepsis policy. It may be noted that CSF cell response may suggest inflammation rather than infection and clinical and other biochemical parameters should be considered.

b) In case of local infection, treatment with dressing and antibiotics as per local policy.

c) In case of loculated hydrocephalus refer to neurosurgery.

d) For possible migration of shunt, consider neuroimaging and contact neurosurgeon.

e) In case of over-drainage resulting in slit like ventricles with VSGS, discuss with neurosurgeon.

3.0 INDICATIONS FOR PERMANENT SHUNT

a) Increasing VI (≥ 97+4mm on Levene's chart) despite regular CSF removal with ventricular tapping.

b) Sub-galeal pocket large in case of ventricular sub-galeal shunt and increasing VI.

c) Small sub-galeal pocket in VSGS and increasing VI/ head circumference.

4.0 REFERENCES

1. de Vries, L., Liem, K., Dijk, K., Smit, B., Sie, L., Rademaker, K. and Gavilanes, A. (2002). Early versus late treatment of post-haemorrhagic ventricular dilatation: results of a retrospective study from five neonatal intensive care units in The Netherlands. *Acta Paediatrica*, 91(2), pp.212-217.
2. Lam, H. and Heilman, C. (2009). Ventricular access device versus ventriculosubgaleal shunt in post-hemorrhagic hydrocephalus associated with prematurity. *The Journal of Maternal-Fetal & Neonatal Medicine*, pp.1-5.
3. Fountain, D., Chari, A., Allen, D. and James, G. (2015). Comparison of the use of ventricular access devices and ventriculosubgaleal shunts in posthaemorrhagic hydrocephalus: systematic review and meta-analysis. *Child's Nervous System*, 32(2), pp.259-267.
4. Mazzola, C., Choudhri, A., Auguste, K., Limbrick, D., Rogido, M., Mitchell, L. and Flannery, A. (2014). Pediatric hydrocephalus: systematic literature review and evidence-based guidelines. Part 2: Management of posthemorrhagic hydrocephalus in premature infants. *Journal of Neurosurgery: Pediatrics*, 14(Supplement_1), pp.8-23.
5. Wellons, J., Shannon, C., Holubkov, R., Riva-Cambrin, J., Kulkarni, A., Limbrick, D., Whitehead, W., Browd, S., Rozzelle, C., Simon, T., Tamber, M., Oakes, W., Drake, J., Luerssen, T., Kestle, J. (2017). Shunting outcomes in posthemorrhagic hydrocephalus: results of a Hydrocephalus Clinical Research Network prospective cohort study. *Journal of Neurosurgery: Pediatrics*, 20(1), pp.19-29.
6. Köksal, V. and Öktem, S. (2010). Ventriculosubgaleal shunt procedure and its long-term outcomes in premature infants with post-hemorrhagic hydrocephalus. *Child's Nervous System*, 26(11), pp.1505-1515.
7. Christian, E., Melamed, E., Peck, E., Krieger, M. and McComb, J. (2016). Surgical management of hydrocephalus secondary to intraventricular hemorrhage in the preterm infant. *Journal of Neurosurgery: Pediatrics*, 17(3), pp.278-284.
8. Ellenbogen, J., Waqar, M. and Pettorini, B. (2016). Management of post-haemorrhagic hydrocephalus in premature infants. *Journal of Clinical Neuroscience*, 31, pp.30-34.
9. Tenbrock, K. (2003). Hyponatraemia as a consequence of serial liquor punctures in preterm infants with a ventricular access device after posthaemorrhagic hydrocephalus. *Archives of Disease in Childhood - Fetal and Neonatal Edition*, 88(4), pp.351F-351.
10. El-Dib M, Limbrick Jr. DD, Inder T, Whitelaw A, Kulkarni AV, Warf B, Volpe JJ, et al. Management of Post-hemorrhagic Ventricular Dilatation in the Preterm Infant The Journalof Pediatrics (2020), doi: https://doi.org/10.1016/j.jpeds.2020.07.079

APPENDIX 1

A. Evidence (Mazzola et al., 2014)

a) VSGS reduces the need of permanent shunt and need for daily CSF aspiration. VSGS also decreases the rate of infection (Level II & Level III evidence).

b) The routine use of serial lumbar is not recommended to reduce the need for shunt insertion or to avoid the progression of hydrocephalus (Level 1 evidence).

c) There is insufficient evidence to recommend a specific infant weight or CSF parameter to direct the timing of shunt placement in preterm infant with PHVD (Level III evidence).

d) CSF cell count, protein, and glucose levels were not statistically related to the occurrence of shunt failure or infection (Level III).

B. **Complications associated with VR and VSGS (2020)[10]**

	Ventricular reservoir (%)	Ventricular Sub-galeal shunt (%)
Obstruction	7.3	9.6
Infection	9.5	9.2
Revision of shunt	10.8	12.2
CSF leak	6	4.7-6.5
Porencephalic Cysts		8.7
Intracranial haemorrhage		1.1