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Case Series: Anaesthetic Management Of Paediatric Patients Of Age Group 1 Month To 5 Years With Hydrocephalus Posted For Ventriculoperitoneal Shunt Surgery

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ABSTRACT

Introduction: Hydrocephalus is the abnormal enlargement of the cerebral ventricles caused by a disruption in the normal flow of cerebrospinal fluid (CSF). In children over the age of two, signs of intracranial pressure increase are more likely to be seen, often accompanied by progressive enlargement of the head. The surgical placement of a shunt is the primary treatment for hydrocephalus in cases with worsening neurological symptoms or significant increase in head size.

Aims and Objectives: The perioperative anaesthetic management of a child with severe hydrocephalus is challenging due to the increased head size and possible associated congenital heart defects and neural tube abnormalities.

Materials and Methods: This case report discusses a child with severe hydrocephalus scheduled for emergency ventriculo-peritoneal (VP) shunt placement who presented with a difficult airway. A towel was placed beneath the shoulders to facilitate intubation, and the child was positioned properly with a difficult airway cart on standby. Anaesthesia was induced with sevoflurane inhalation, and after reaching adequate depth, the child was intubated on the first attempt using a Macintosh blade size 1. A 3.5 mm ID uncuffed endotracheal tube was inserted and secured at 9 cm after confirming equal bilateral breath sounds. During surgery, the child was maintained on a mixture of oxygen, nitrous oxide, and sevoflurane.

Conclusion: Managing a child with severe hydrocephalus is challenging due to potential airway difficulties, positioning issues, and associated congenital anomalies. Ensuring proper positioning and preparing for a difficult airway are critical for safe anaesthesia management.

Keywords: *Hydrocephalus, Difficult Airway, Pediatric anaesthesia, Neurosurgery*

1. INTRODUCTION

Hydrocephalus is a disorder of abnormal cerebrospinal fluid (CSF) accumulation in the ventricles that leads to ventricular dilation and increased intracranial pressure (ICP). It is derived from the Greek word hydro, which means “water” and cephalus means “head,” a condition in which there is an imbalance between CSF formation and absorption, resulting in excessive accumulation of CSF in ventricles.

Anesthetic considerations in pediatric patients with hydrocephalus are often intricate since children with congenital hydrocephalus are likely to have extensive multisystem disorders, such as congenital heart disease or major spinal defects linked to premature birth. Prolonged sedation, upper airway obstruction and postoperative hypoxia may lead to delayed recovery.(1)

Epidemiology:

Hydrocephalus is more common in developing countries, where the incidence is higher due to limited access to prenatal care and delayed surgical intervention. If not detected early, hydrocephalus can lead to serious neurological issues, cognitive impairments, motor problems, and vision difficulties in children. The standard treatment for hydrocephalus is ventriculo-peritoneal (VP) shunting, but it carries significant risks, especially in children. Research indicates that shunt failure is most

likely to occur within the first six months after surgery, with failure rates reaching as high as 46%. Complications such as infections, blockages, and mechanical malfunctions can further hinder the effectiveness of the treatment, placing emotional and financial burdens on families.

Although VP shunting is the standard treatment, it still carries considerable risks. The healthcare system in India faces numerous challenges when dealing with complex neurosurgery cases, making it difficult to assess the safety and effectiveness of VP shunting in infants. The outcomes and issues are unique and differ from those in more developed countries, where healthcare infrastructure is more advanced.

Goals of anaesthetic management:

Major goals for Management of child with gross hydrocephalus are:

1) Airway management

2) Smooth induction and emergence

3) To control increase in intracranial pressure

4) To maintain Cerebral perfusion pressure

5) Monitoring and prevention of complications, morbidity and mortality

6) Postoperative care

Anatomy and pathophysiology of hydrocephalus in children:

Anatomy Overview

Cerebrospinal Fluid (CSF) System:

Production: CSF is primarily produced by the choroid plexus located in the lateral, third, and fourth ventricles.

Circulation Pathway:

1. Lateral ventricles
2. Interventricular foramen (of Monro)
3. Third ventricle
4. Cerebral aqueduct (of Sylvius)
5. Fourth ventricle
6. Foramina of Luschka and Magendie
7. Subarachnoid space
8. Arachnoid villi into the superior sagittal sinus (venous absorption)

Pathophysiology of Hydrocephalus:

Hydrocephalus occurs due to a disruption in CSF production, flow, or absorption, leading to excessive accumulation.

Types of Hydrocephalus:

1. Communicating Hydrocephalus:

Cause: Impaired absorption of CSF at the arachnoid villi or overproduction (rare).

Flow: CSF flows freely through the ventricles.

Common causes: Meningitis, intraventricular hemorrhage (IVH), congenital abnormalities.

2. Non-communicating (Obstructive) Hydrocephalus:

Cause: Physical obstruction within the ventricular system.

Causes: Congenital malformations (e.g., Chiari malformations), tumors, cysts.

3. Hydrocephalus ex vacuo:Cause: Brain atrophy leading to compensatory ventricular enlargement (not true hydrocephalus).

4. Normal Pressure Hydrocephalus (NPH): Rare in children, typically affects the elderly.

2. PAEDIATRIC CONSIDERATIONS

Infants (open sutures): Increased head circumference, bulging fontanelles, irritability, poor feeding.

Older children (closed sutures): Signs of increased intracranial pressure (headache, vomiting, papilledema).

Clinical Consequences:

Increased intracranial pressure

Impaired cerebral perfusion

Potential brain tissue damage and developmental delay

Visual disturbances due to papilledema or optic atrophy

Case 1:

A 11-month-old male child, full term delivered vaginally, cried immediately after birth, with no history of NICU admission, referred to our hospital with complains of gradual increase in head size and irritability for 8 months

On pre anaesthetic evaluation patient was vitally stable, with sunset sign positive. On CVS Examination S1,S2 normal, no added sound. Other systemic examination was normal. All investigation were within normal limits. Occipitofrontal circumference was 55.cm (N: 32 to 35 cm), weighing 7.8 kg with dilated scalp veins, visual acuity couldn't be assessed but both pupils were 3mm reacting to light. No any sensorimotor deficits were present. No delaying of milestones was observed. Child was taken for surgery under ASA class 3 sos post operative ventilator support.

MRI Brain was suggestive of dilation of third and fourth ventricle and thinning of brain parenchyma. Exaggerated flow void at the level of aqueduct with dilation of fourth ventricle favoring the possibility of communicating hydrocephalus.

Preoperatively: After placing adequate padding below shoulders to ease intubation, proper positioning was ensured along with difficult cart kept ready. Baby warmer was kept in order to prevent hypothermia.

Induction: Inhalational induction was done with Sevoflurane, after achieving adequate depth of anaesthesia, child was intubated in first attempt with macintosh blade no. 1, Cormack and lahane grading 2, uncuffed endotracheal tube of 3.5 mm ID was inserted, tube was fixed at 9 cm after confirming bilateral equal air entry.

Maintenance: Oxygen, Nitrous oxide and Sevoflurane. Intraoperatively patient remained hemodynamically stable.

Monitoring: continuous vigilant monitoring was done using **auscultation at precordium and electrocardiogram**, **pulse volume** was monitored and fluid management was done accordingly to avoid hypovolemia, **temperature monitoring** was done and the body of patient was covered to prevent hypothermia, using **ETCO2** normocapnia was maintained in order to maintain cerebral perfusion, **Saturation** monitoring was done continuously to avoid any kind of hypoxemia. (2)

Postoperative Extubation: After 2 hours of surgery, initiation of spontaneous respiration and achievement of protective airway reflexes patient was extubated, after adequate monitoring in PACU patient was shifted to PICU. Patient was discharged successfully after 2 weeks

Case 2:

A 11-month-old male child, full term delivered vaginally, cried immediately after birth, with no history of NICU admission, referred to our hospital with complains of gradual increase in head size and irritability since birth

On pre-anaesthetic evaluation patient was vitally stable, with sunset sign positive. On CVS Examination S1, S2 normal, no added sound. Other systemic examination were normal. All investigations were within normal limits. Occipitofrontal circumference was 43.cm (N: 32 to 35 cm), weighing 10 kg with dilated scalp veins, visual acuity couldn't be assessed but both pupils were 3mm reacting to light. No any sensorimotor deficits were present. No delaying of milestones was observed. Child was taken for surgery under ASA class 3 sos post operative ventilator support.

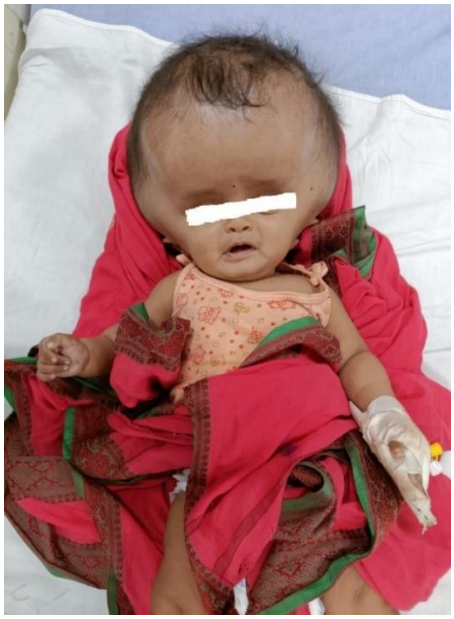
Preoperatively: After placing adequate padding below shoulders to ease intubation, proper positioning was ensured along with difficult cart kept ready. Baby warmer was kept in order to prevent hypothermia.

Induction: Inhalational induction was done with Sevoflurane, after achieving adequate depth of anaesthesia, child was intubated in first attempt with macintosh blade no. 1, Cormack and lahane grading 2, uncuffed endotracheal tube of 4 mm ID was inserted, tube was fixed at 10 cm after confirming bilateral equal air entry.

Maintenance: Oxygen, Nitrous oxide and Sevoflurane. Intraoperatively, patient remained hemodynamically stable.

Monitoring: continuous vigilant monitoring was done using **auscultation at precordium and electrocardiogram**, **pulse volume** was monitored, fluid management was done accordingly to avoid hypovolemia, **temperature monitoring** was done and the body of patient was covered to prevent hypothermia, using **ETCO2** normocapnia was maintained in order to maintain cerebral perfusion, **Saturation** monitoring was done continuously to avoid any kind of hypoxemia.

Postoperative Extubation: After 90 minutes of surgery, initiation of spontaneous respiration and achievement of protective airway reflexes patient was extubated, after adequate monitoring in PACU patient was shifted to PICU. Patient was discharged successfully after 1 week.



Case 3:

A 3-month-old male child, full term delivered vaginally, cried immediately after birth, with no history of NICU admission, referred to our hospital with complains of gradual increase in head size and irritability for 2 months

On pre anaesthetic evaluation patient was vitally stable, with sunset sign positive. On CVS Examination S1, S2 normal, no added sound. Other systemic examinations were normal. All investigations were within normal limits. Occipitofrontal circumference was 55.cm (N: 32 to 35 cm), weighing 5 kg with dilated scalp veins, visual acuity couldn't be assessed but both pupils were 3mm reacting to light. No any sensorimotor deficits were present. No delaying of milestones was observed. Child was taken for surgery under ASA class 3 sos post operative ventilator support. (3)

Preoperatively: After placing adequate padding below shoulders to ease intubation, proper positioning was ensured along with difficult cart kept ready. Baby warmer was kept in order to prevent hypothermia.

Induction: Inhalational induction was done with Sevoflurane, after achieving adequate depth of anaesthesia, child was intubated in first attempt with macintosh blade no. 1, Cormack and lahane grading 2, uncuffed endotracheal tube of 3 mm ID was inserted, tube was fixed at 9 cm after confirming bilateral equal air entry.

Maintenance: Oxygen, Nitrous oxide and Sevoflurane. Intraoperatively, patient remained hemodynamically stable.

Monitoring: continuous vigilant monitoring was done using **auscultation at precordium and electrocardiogram**, **pulse volume** was monitored and fluid management was done accordingly to avoid hypovolemia, **temperature monitoring** was done and the body of patient was covered to prevent hypothermia, using **ETCO2** normocapnia was maintained in order to maintain cerebral perfusion, **Saturation** monitoring was done continuously to avoid any kind of hypoxemia.

Postoperative Extubation: After 2 hours of surgery, initiation of spontaneous respiration and achievement of protective airway reflexes patient was extubated, after adequate monitoring in PACU patient was shifted to PICU. Patient was discharged successfully after 1 week.

Case 4:

A 10-day-old male child, preterm delivered vaginally, cried immediately after birth, with no history of NICU admission, referred to our hospital with complains of gradual increase in head size and irritability for 8 months

On pre anaesthetic evaluation patient was vitally stable, with sunset sign positive. On CVS Examination S1, S2 normal, no added sound. Other systemic examinations were normal. All investigations were within normal limits. Occipitofrontal circumference was 40 cm (N: 32 to 35 cm), weighing 2.8 kg with dilated scalp veins, visual acuity couldn't be assessed but both pupils were 3mm reacting to light. No any sensorimotor deficits were present. No delaying of milestones was observed. Child was taken for surgery under ASA class 3 sos post operative ventilator support.

Preoperatively: After placing adequate padding below shoulders to ease intubation, proper positioning was ensured along with difficult cart kept ready. Baby warmer was kept in order to prevent hypothermia.

Induction: Inhalational induction was done with Sevoflurane, after achieving adequate depth of anaesthesia, child was

intubated in first attempt with macintosh blade no. 0, Cormack and lahane grading 2, uncuffed endotracheal tube of 2 mm ID was inserted, tube was fixed at 9 cm after confirming bilateral equal air entry.

Maintenance: Oxygen, Nitrous oxide and Sevoflurane. Intraoperatively, patient remained hemodynamically stable.

Monitoring: continuous vigilant monitoring was done using **auscultation at precordium and electrocardiogram**, **pulse volume** was monitored, fluid management was done accordingly to avoid hypovolemia, **temperature monitoring** was done and the body of patient was covered to prevent hypothermia, using **ETCO2** normocapnia was maintained in order to maintain cerebral perfusion, **Saturation** monitoring was done continuously to avoid any kind of hypoxemia.

Postoperative Extubation: After 45 minutes of surgery, due to failure of initiation of spontaneous respiration and achievement of protective airway reflexes patient could not be exubated, after adequate trails of Extubation, patient was shifted intubated to PICU and kept on HFNO (High frequency Nasal Oxygen) (FiO2: 30%). It was extubated after vigilant monitoring for 2 days. Patient was discharged successfully after 1 week.

Case 5:

A 2.5-month-old female child, full term delivered by caesarean section, cried immediately after birth, with 1 week of NICU admission, referred to our hospital with complains of gradual increase in head size and irritability for 8 months

On pre anaesthetic evaluation patient was vitally stable, with sunset sign positive. On CVS Examination S1, S2 normal, no added sound. Other systemic examinations were normal. All investigations were within normal limits. Occipitofrontal circumference was 67.5cm (N: 32 to 35 cm), weighing 4.9 kg with dilated scalp veins, visual acuity couldn't be assessed but both pupils were 3mm reacting to light. No any sensorimotor deficits were present. No delaying of milestones was observed. Child was taken for surgery under ASA class 3 sos post operative ventilator support.

Preoperatively: After placing adequate padding below shoulders to ease intubation, proper positioning was ensured along with difficult cart kept ready. Baby warmer was kept in order to prevent hypothermia.

Induction: Inhalational induction was done with Sevoflurane, after achieving adequate depth of anaesthesia, child was intubated in first attempt with macintosh blade no. 1, Cormack and lahane grading 2, uncuffed endotracheal tube of 3.5 mm ID was inserted, tube was fixed at 9 cm after confirming bilateral equal air entry.

Maintenance: Oxygen, Nitrous oxide and Sevoflurane. Intraoperatively, patient remained hemodynamically stable.

Monitoring: continuous vigilant monitoring was done using **auscultation at precordium and electrocardiogram**, **pulse volume** was monitored, and fluid management was done accordingly to avoid hypovolemia, **temperature monitoring** was done and the body of patient was covered to prevent hypothermia, using **ETCO2** normocapnia was maintained in order to maintain cerebral perfusion, **Saturation** monitoring was done continuously to avoid any kind of hypoxemia.

Postoperative Extubation: After 1 hour of surgery, initiation of spontaneous respiration and achievement of protective airway reflexes patient was extubated, after adequate monitoring in PACU patient was shifted to PICU. Patient was discharged successfully after 2 weeks

Case 6:

A 1-year-old female child, preterm delivered by caesarean section, cried immediately after birth, with 1 week of NICU admission, referred to our hospital with complains of gradual increase in head size and irritability and projectile vomiting since 3 months.

On pre anaesthetic evaluation patient was vitally stable, with sunset sign positive. On CVS Examination S1, S2 normal, no added sound. Other systemic examinations were normal. All investigations were within normal limits. Occipitofrontal circumference was 45cm (N: 32 to 35 cm), weighing 6.5kg with dilated scalp veins, visual acuity couldn't be assessed but both pupils were 3mm reacting to light. No sensorimotor deficits were present. No delaying of milestones was observed. Child was taken for surgery under ASA class 3 sos post operative ventilator support.

MRI was suggestive of arachnoid cyst, Evidence of a well-defined CSF-intensity lesion consistent with an arachnoid cyst, causing mass effect with associated ventriculomegaly, suggestive of obstructive hydrocephalus. Notable thinning of the corpus callosum is observed, likely secondary to chronic ventricular dilatation

Preoperatively: After placing adequate padding below shoulders to ease intubation, proper positioning was ensured along with difficult cart kept ready. Baby warmer was kept in order to prevent hypothermia.

Induction: Inhalational induction was done with Sevoflurane, after achieving adequate depth of anaesthesia, child was intubated in first attempt with macintosh blade no. 1, Cormack and lahane grading 2, uncuffed endotracheal tube of 4.5 mm ID was inserted, tube was fixed at 11 cm after confirming bilateral equal air entry.

Maintenance: Oxygen, Nitrous oxide and Sevoflurane. Intraoperatively, patient remained hemodynamically stable.

Monitoring: continuous vigilant monitoring was done using **auscultation at precordium and electrocardiogram**, **pulse**

volume was monitored, and fluid management was done accordingly to avoid hypovolemia, **temperature monitoring** was done and the body of patient was covered to prevent hypothermia, using **ETCO2** normocapnia was maintained in order to maintain cerebral perfusion, **Saturation** monitoring was done continuously to avoid any kind of hypoxemia.

Postoperative Extubation: After 1 hour of surgery, initiation of spontaneous respiration and achievement of protective airway reflexes patient was extubated, after adequate monitoring in PACU patient was shifted to PICU. Patient was discharged successfully after 2 weeks

3. DISCUSSION

Hydrocephalus is complex clinical condition in which CSF accumulation occurs due to various causes. However cerebrospinal shunt procedures prove to be lifesaving since it prevents worsening of neurology. Management in these patients pose a challenge since they do have chances of congenital anomalies.(4)

Major complications of shunt surgeries are blockage, infection, malfunction which requires further revision surgery.

Increased ICP can cause cerebral atrophy, worsening of neurology and may delay milestones and cause mental retardation in child with hydrocephalus.

The major goals of anaesthetic management should be thorough preoperative checkup, intraoperative fluid, management for adequate cerebral perfusion and euvolemia with isotonic fluids that do not cause hyperglycemia. (5)

4. CONCLUSION

Management of child with gross hydrocephalus can be a challenge due to difficult airway, positioning, congenital anomalies in some cases cardiovascular instabilities. In order to secure the airway of child proper positioning is mandatory.

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