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Perioperative management of minimally invasive off pump coronary artery bypass grafting in a case of normal pressure hydrocephalus (NPH): A robust challenge to anaesthesiologists

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Abstract
Normal Pressure Hydrocephalus (NPH) is a potentially reversible neurodegenerative disease characterized by a triad of dementia, gait and urinary disturbance. Advancements in diagnosis and treatment have helped in improving symptoms in patients. We report a 60-year-old male patient diagnosed with NPH having coronary artery disease, who was treated with off-pump minimally invasive cardiac surgery-coronary artery bypass grafting (MICS-CABG). Intraoperative management of such a case is particularly challenging because raised ICP can cause brain injury and adverse outcome. One lung ventilation (OLV) during MICS further makes the patients more vulnerable to hypoxic injury and fluctuating haemodynamics can further worsen the situation. Our case had done well and was discharged on fifth day of surgery.

Keywords: Normal pressure hydrocephalus, minimally invasive cardiac surgery, off pump coronary artery bypass grafting

Introduction
Normal Pressure Hydrocephalus (NPH) is a neurocognitive disease and one of the only reversible causes of dementia. Its prevalence is 0.3% to 3% of people > 65 years old, but it is often non-diagnosed or misdiagnosed. Its main symptoms are a triad of gait disturbance, urinary incontinence and dementia. Although not all patients have all three [1]. Diagnosis is usually confirmed by an MRI brain scan and cerebrospinal fluid flow studies. Treatment usually involves ventriculoperitoneal shunt surgery [2].

For patients with NPH needing cardiac surgery, care should be taken not to increase intracranial pressure (ICP) because this may cause serious complications [3, 4]. We report a 60-year-old male patient with previous diagnosis of NPH having coronary artery disease and was treated with off-pump minimally invasive cardiac surgery-coronary artery bypass grafting (MICS-CABG). This was a rare high-risk case because of multiple comorbidities. Though limited case reports are available in the literature worldwide for cardiac surgeries specially valve surgeries in NPH5 patients but MICS-off pump CABG in such patients has not been reported in literature till date.

Case Report
A 60-year-old male patient presented in the emergency department with complaints of severe chest pain on exertion. He was diabetic and hypertensive.

ECG revealed ST depression in lead V1-V6 and T inversion in lead II, III, aVF. He underwent coronary angiogram which revealed triple vessel coronary artery disease with 80% block proximal Left Anterior Descending artery (LAD), 80% block in Left Circumflex (LCX), 70% in obtuse marginal artery (OM) and 90% block in the Right Coronary Artery (RCA). He was initially medically managed for the acute chest pain with heparin and antiplatelets and after seven days he was scheduled for a coronary artery bypass graft surgery. In addition to Ischemic Heart Disease (IHD), the patient also had ataxia and gait apraxia with hypermetric saccades and dysarthria. In the recent past he had frequent episodes of Urinary Tract Infections (UTI) symptoms of which were superimposed on urinary incontinence.

Because of the neurological symptoms, he had consulted a neurologist six months ago and had undergone a CSF lumbar tap where a high volume tap and gait improvement on serial CSF drainage had established the diagnosis of NPH. At present since he was awaiting a cardiac surgery, a neurologist referral was requested in view of NPH and its concerns during a heart surgery. MRI brain was conducted which revealed bilateral cerebral and cerebellar atrophy, with ischemic changes in bilateral periventricular region and dilated supratentorial ventricular system with interstitial oedema around the lateral ventricles, narrow callosal angle and high Evans index which indicated ventriculomegaly [Figure 1]. T_2-weighted fast spin-echo, axial images showed a section through the aqueduct and upper fourth ventricle showing CSF flow void [Figure 2]. CSF tap was not done this time, keeping in mind the antiplatelets and heparin he was administered. He was started on oral Amantadine 100 mg thrice a day and Riluzole 50 mg twice a day. Neurologist had advised to go ahead with the heart surgery. After conducting all the routine preoperative investigations, he was shifted to the operating theatre where all the standard American Society of Anaesthesiologists (ASA) monitors were placed. A broad-gauge peripheral line (16G) and right radial arterial line (20G) were secured. Since the patient had a moderate left ventricular dysfunction, we planned to put a central venous line and a pulmonary artery catheter under local anaesthesia with ultrasound guidance before giving general anaesthesia. Inotropes and vasodilators were attached. Near-infrared spectroscopy (NIRS) electrodes were placed on the forehead for baseline values and was found to be around 50% (right) and 55% (left). Intravenous lignocaine 2% 1.5 mg/kg was administered 90 seconds before induction, midazolam 0.02 mg/kg, fentanyl citrate 5 mcg/kg, propofol 2mg/kg, rocuronium bromide 1mg/kg were used to induce general anaesthesia. A video-laryngoscope was used electively for intubation to reduce the stress response. A trans-oesophageal echocardiography (TEE) probe was inserted. One lung ventilation (OLV) was initiated with bronchoscopy guided EZ endobronchial blocker placement and left lung isolation was done. Saturation was around 92-94% at FiO2 of 60%. Continuous positive airway pressure (CPAP) of around 5 cm H_2O was provided to the non-ventilated lung to keep the oxygen saturation above 94%. pCO_2 (monitored with serial arterial blood gas samples) was kept in the range of 30-35 mm Hg by adjusting the respiratory rate of around 20-24 per minute and also by continuous monitoring of $EtCO_2$ values which were corelating well with pCO_2. The patient was positioned 30-degree head up to reduce the venous return. Mean arterial pressure was maintained to 70-80 mm Hg by phenylephrine top-up doses and Noradrenaline infusion. OLV initiation caused the pulmonary artery systolic pressure (PAP) to rise up to 40-45 mm Hg. To bring down the PAP to around 35 mm Hg and maintaining central venous pressure (CVP) at a range of 6-8 mm Hg, furosemide 10 mg was given. Mannitol 20% IV 1gm/kg was given over 30 minutes prophylactically to reduce cerebral oedema (as detected in the MRI and as advised by the neurologist). Dexamethasone 8 mg and Magnesium sulphate 50% 2gm IV were also administered. Electrolytes were checked by arterial blood gas samples and corrected hourly. Urine output was aimed and maintained ≥ 1ml/kg/hour intraoperatively. End tidal Sevoflurane of 1.8-2 volume% was maintained. Heparin (2 mg/kg) was given to maintain an ACT of around 300-350 seconds. The surgery was performed with off-pump beating heart technique by left anterior thoracotomy approach and three grafts were done namely LIMA (left internal mammary artery)-LAD, RSVG (reverse saphenous venous graft) to OM, RSVG to posterior descending artery (PDA) [Figure 3]. A core temperature (nasopharyngeal) between 35.5-37 degrees was maintained. The haemoglobin was maintained above 9gm/dl during surgery by transfusing of one unit packed red blood cell. The NIRS values intraoperatively were found to be within 10-15% of the baseline values, i.e., 45% (right) and 47% (left). After completion of the grafting, protamine (1 mg/100 IU of heparin) was given and haemostasis was achieved. The patient was transferred to the cardiovascular intensive care unit with dexmedetomidine infusion at 0.5 mcg/kg/hour for sedation, fentanyl infusion 20 mcg/hour for analgesia and minimal vasopressor support of Noradrenaline at 0.02 µg/kg/min. Chest drain output was monitored for 2-3 hours and then dexmedetomidine was tapered off. NIRS was monitored till he was fully awake. The patient was weaned from the ventilator and extubated at about 5 hours of surgery without any neurological or cardiac sequelae. Physiotherapy was started carefully the next day keeping in mind his ataxia. He was discharged on the fifth day of surgery with ICU stay being three days. He was given dual antiplatelets, 75 mg aspirin and 75 mg clopidogrel, antihypertensives, diuretics and neuro protective medications as started in the pre-operative period. He was discharged with a foley silicon catheter since he had a preoperative loss of bladder control. On his one-month follow-up, the patient was doing well with no cardiac problems and there was no exacerbation of his baseline neurological issues.

Discussion

Normal Pressure Hydrocephalus (NPH) is an idiopathic clinical complex caused by the build-up of cerebrospinal fluid (CSF) and is characterized by a triad of abnormal gait, urinary incontinence, and dementia. Although not all patients have all three.1 NPH can also have atypical presentation like transient visual cognitive disorders.6 Patients with NPH should undergo imaging studies. CSF flow rate of > 24.5 mL/min is 95% specific for NPH.7 Improvement in symptoms with CSF drainage rules in favour of NPH.8 There is a well-established correlation between higher flow velocities and the favorable outcome after ventriculoperitoneal shunting; hence, quantitative methods have been developed which can be useful not only in patient selection for shunting but also in diagnosis and predicting prognosis [9]. It is seen that when patients are selected on the basis of clinical and imaging features, 80% response favorably to CSF diversion [10]. Since our patient had a severe triple vessel coronary artery disease, he was scheduled for a MICS-CABG surgery as the patient had opted for it despite being explained about the risks of the same on his present neurological ailment. Though MICS decreases the incidence of postoperative respiratory dysfunction, chronic pain, chest instability, deep sternal wound infection, bleeding, atrial fibrillation and hospital stay, the risk of hypoxia, hypercarbia and acidosis during OLV in MICS surgery can have serious neurological consequences in such a case. There are robust challenges to conduct MICS-CABG in patients with NPH. Preventing cerebral vasodilatation and cerebral oedema is the primary

goal here. Measures that can be taken to reduce the stress response during laryngoscopy and intubation are using a video-laryngoscope, administering drugs like lignocaine, fentanyl, and esmolol sometimes. Steps should be taken to avoid hypoxia, hypercarbia and hyperthermia, which can result in cerebral vasodilatation [5]. Mild head up position will favour venous drainage and maintaining a CVP of less than 10 mm Hg is advocated [5]. Also, diuretics can reduce the CVP. Mannitol and dexamethasone are known to reduce ongoing cerebral oedema if evident in the imaging studies [5]. Also hourly serial blood gas analysis have to be done to timely correct the electrolytes. NIRS values with a relative decrease of more than 20% from baseline values will suggest significant cerebral desaturation and effective measures to be taken to correct it.

Careful settings of OLV can be challenging while maintaining adequate oxygenation and preventing hypercarbia and haemodynamic changes. Mild controlled hypocarbia (pCO_2 30-35 mm Hg) can effectively control increase in cerebral blood flow [5]. Oxygen saturation above 94% is advisable. Efforts to achieve the same during OLV include increasing the fractional inspired oxygen (FiO2) and giving CPAP to the non-dependent lung and PEEP to the dependent lung. Till date there is no case report available in literature of a case of NPH undergoing MICS off-pump-CABG. Our case was intensely monitored perioperatively and the treatment was titrated carefully. He was discharged home without any complications.

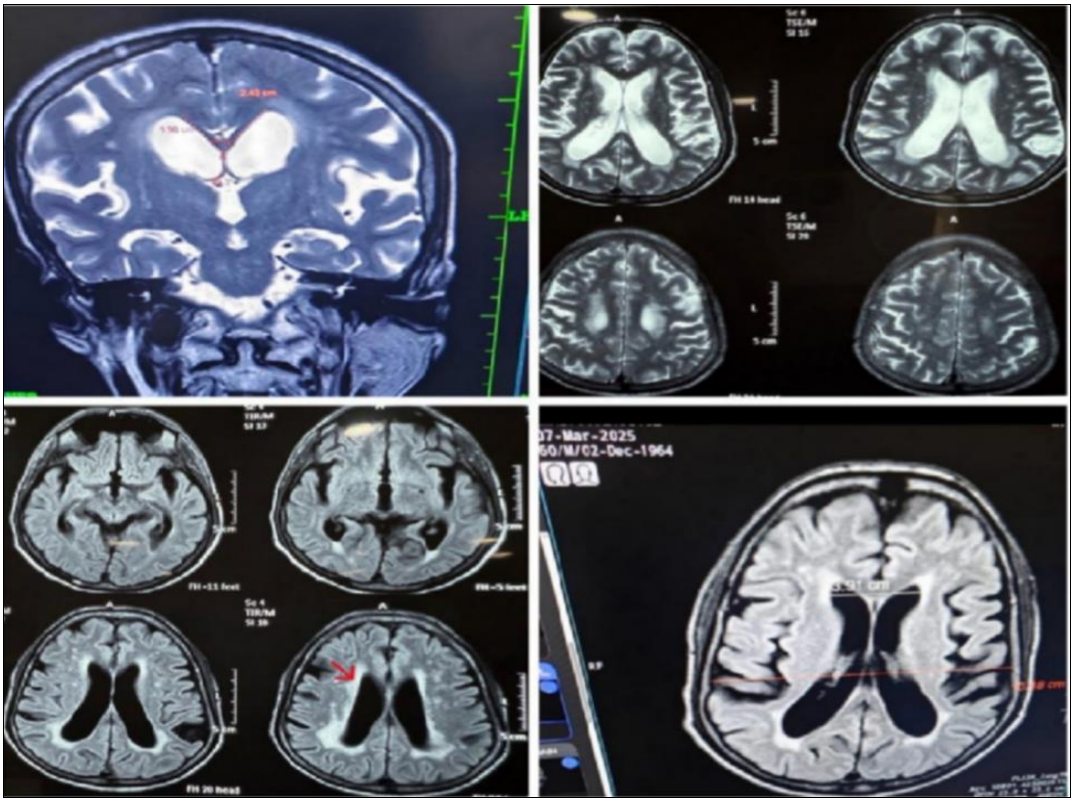

Fig 1: MRI brain top left coronal image showing dilated supratentorial ventricular system, dilated sylvian fissure with narrow upward bowing of callosal angle of 79 degrees (which is less than 90 degrees), top right showing dilated ventricles with superficial sulci, below left axial image showing interstitial edema around the lateral ventricles (in red arrow), below right axial image showing two lines depicting the Evans index which is the ratio of the maximum width of the frontal horns of lateral ventricles and maximal internal diameter of the skull that comes out to be 0.29 here, which denotes ventriculomegaly.

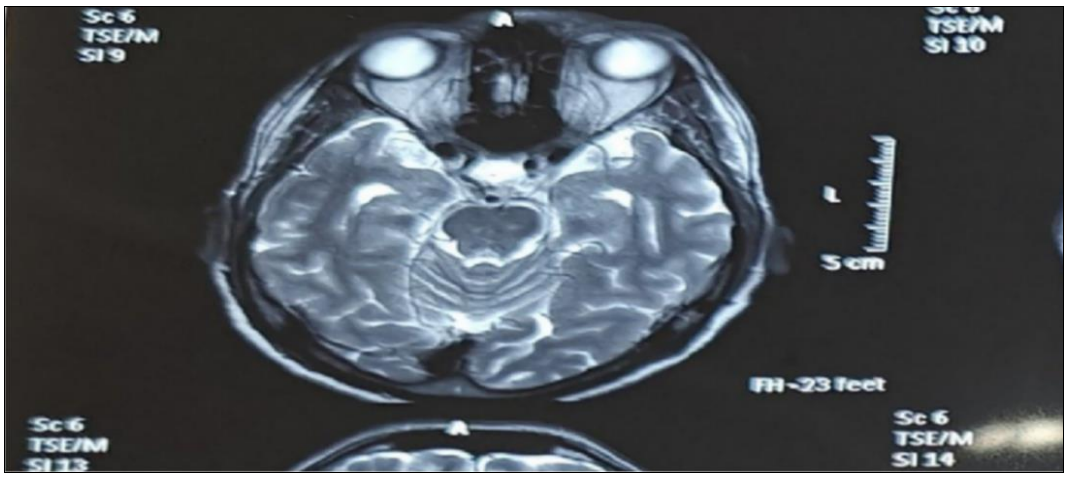

Fig 2: T_2-weighted fast spin-echo axial MRI section through the aqueduct and upper fourth ventricle showing CSF flow void, which is specific for hyperdynamic flow.

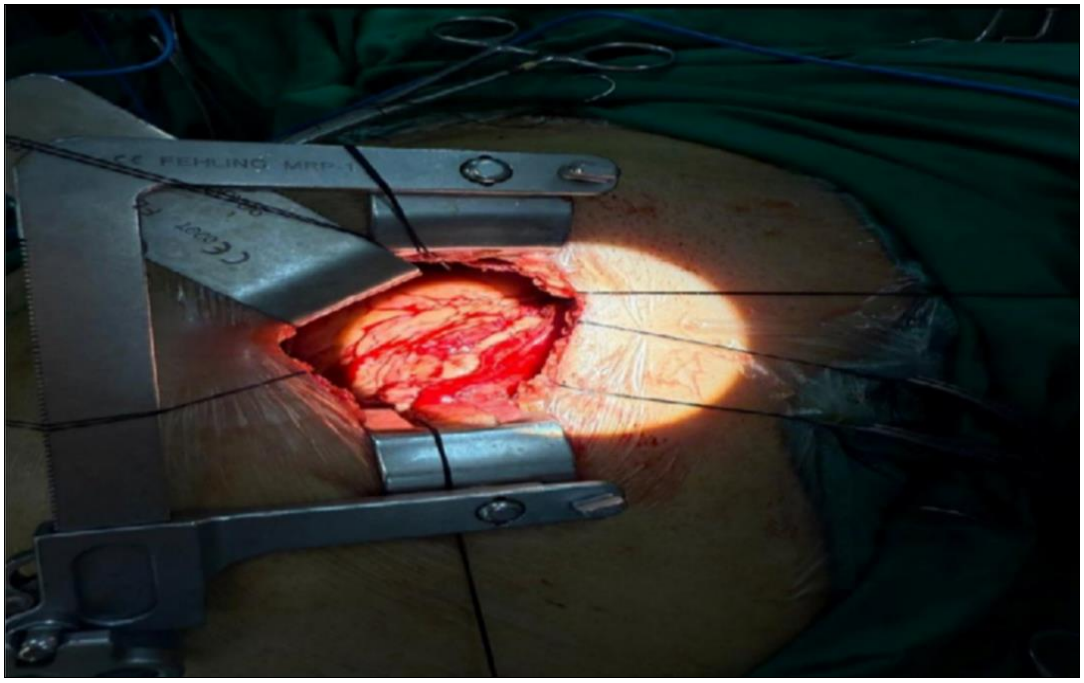

Fig 3: MICS-CABG by left lateral anterior thoracotomy incision

Conclusion

A multidisciplinary panel of neurologists, neurosurgeons, cardiac anaesthesiologists, cardiac surgeons, perfusionists and should holistically treat such patients with a goal to prevent cerebral oedema while undergoing surgery. Understanding the physiology and risk factors before surgery and active interventions to prevent them are key for good outcome. We conclude that MICS-CABG can be conducted safely in a NPH patient with adequate monitoring and management for favorable outcome.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given his consent for the images and other clinical information to be reported in the journal. The patient understands that his name and initials will not be published and due efforts will be made to conceal his identity, but anonymity cannot be guaranteed.

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Conflicts of Interest

There are no conflicts of interest.

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