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Anaesthetic Management of a Paediatric Case of G6pd Deficiency Posted for Craniotomy

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Abstract

Glucose-6-Phosphate Dehydrogenase deficiency is an inherited X-linked enzymatic disorder that results in haemolytic anaemia whenever the body faces oxidative stress in circumstances such as drug interactions (including anaesthetic agents), infections and surgical stress. A complete pre-anaesthetic evaluation, thorough planning of anaesthetic technique and adequate monitoring helps avoid oxidative stress in the perioperative period. The authors report the successful management of a 9-month old child with G6PD deficiency who underwent craniotomy with no acute or delayed complications of the condition.

Keywords: Glucose-6-Phosphate, Haemolysis, Neuroanaesthesia

1. Introduction

The enzyme Glucose 6-Phosphate Dehydrogenase (G6PD), is involved in two important biochemical reactions in the red blood cells namely the Embden-Meyerhof pathway and the Hexose Mono-Phosphate (HMP) shunt pathway[1,2]. During these reactions, Nicotinamide Adenine Dinucleotide Phosphate (NADP) which is a hydrogen donor in the body is generated continuously. This maintains reduction of glutathione (GSH) and thus prevents oxidative stress. Mutation of the gene on the X chromosome which encodes G6PD predisposes patients to haemolytic anaemia whenever there is oxidative stress[3,4]. Under general anaesthesia, the immediate signs of haemolysis get masked and hence identification of a haemolytic crisis is difficult. We describe the successful perioperative management of a 9-month child with G6PD deficiency that underwent craniotomy.

2. Case Report

A 9-month-old boy was brought with a ten-day history of swelling in the post auricular region, associated with change in voice, drooping of the left eyelid and restlessness. He was a known case of G6PD deficiency diagnosed at the age of 7 months when he had an episode of acute gastroenteritis. Family history of G6PD deficiency was present as seen in his elder brother aged 5 years. Birth history as per medical records showed that child was delivered full term via vaginal delivery. Birth weight was 3 kg. He was admitted in the Neonatal Iintensive Care Unit (NICU) for a day due to congenital hyperbilirubinemia for which he received phototherapy.

On general physical examination, weight of the child was 8 kgs, he was awake, alert and there was facial asymmetry and hoarseness of voice while crying. Right-side torticollis was noted. Ear, nose and throat were found to be normal. Facial asymmetry was suspected to be due to Cranial nerve VII involvement below the nucleus (LMN lesion) (Figure 1).

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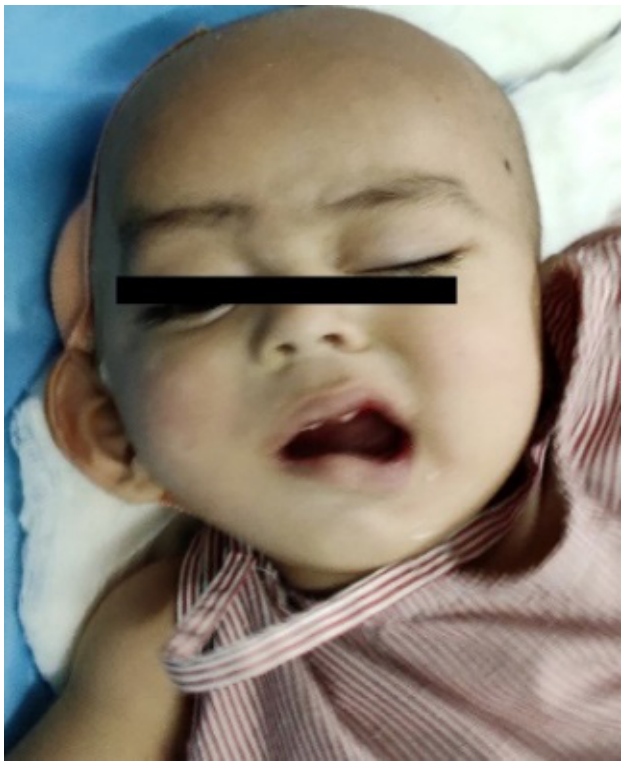

Figure 1. Facial appearance of the child.

On palpation, there was a post auricular swelling, 3*3 cm, nodular and firm in consistency and right cervical lymphadenopathy (Level V), multiple, firm to hard in consistency, largest lymph node measuring about 1*1cm. Liver was palpable 4 cm below right costal margin, with liver span of 7cm. Spleen was palpable 3cm below left costal margin. Developmental milestones were appropriate for age. Immunisation was up to date. There were no signs of raised ICT i.e. there was no bradycardia, irregular respiration or high BP readings. BP monitored hourly was found to be appropriate for age at 90-95th percentile. Fundus examination revealed disc pallor, disc margins were found to be regular and there was no papilledema.

Magnetic Resonance Imaging (MRI) was done which showed a right sided lytic lesion with heterogeneously enhancing soft tissue component involving the right temporal bone measuring 57*46 mm (extra-axial) with mass effect on right cerebellar hemisphere (Figure 2). A possibility of Langerhans cell histiocytosis/eosinophilic granuloma and a differential diagnosis of Ewing's Sarcoma or metastasis were considered. USG Abdomen showed multiple well defined heteroechoic lesions in both hepatic lobes, largest in right lobe measuring 5.4*5 cm suggestive of metastasis.

Child was planned for craniotomy and tumor excision under general anaesthesia in the supine position. The patient was started on Leviteracetam (80mg IV BD) as well as mannitol (10 ml 0f 20% mannitol OD), dexamethasone (2 mg IV QID) and glycerol (5 ml per oral TID) to reduce intracranial pressure and decrease brain oedema. Routine pre-operative baseline investigations including haemoglobin, electrolytes, renal function tests, coagulation profile were done, all of which were within

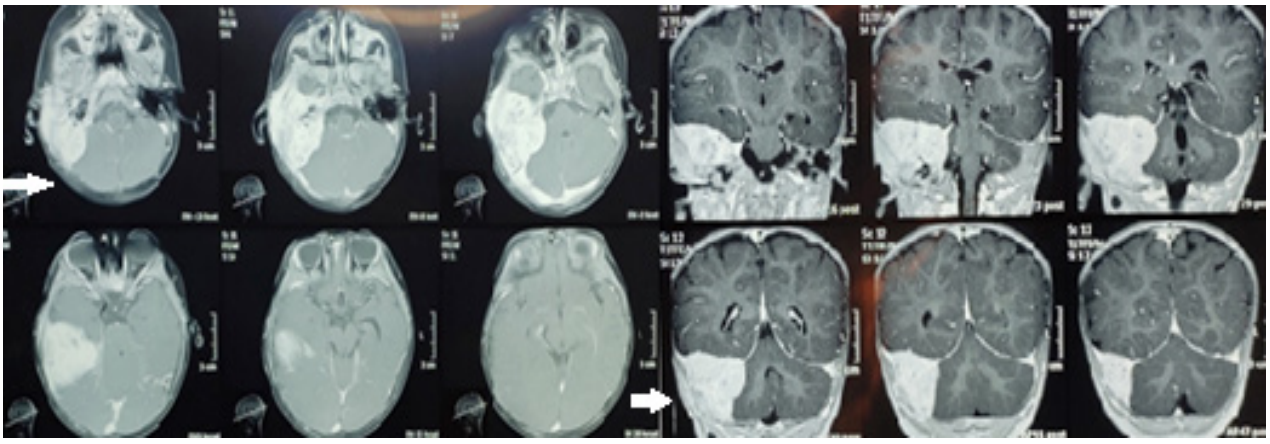

Figure 2. CT brain showing lesion.

normal limits. Liver function tests showed a mildly elevated Aspartate Transaminase (AST) of 61 Units/L. Echocardiogram was normal. Procedure was explained to the bystanders and written informed consent was obtained for the same. Need for postoperative mechanical ventilation in case of complications and specific risks related to G6PD deficiency such as acute and delayed haemolysis were explained to the bystanders. Child was kept nil per oral as per guidelines prior to surgery.

On arrival to OT, child was awake and alert. Standard American Society of Anaesthesiology (ASA) monitors were connected and baseline haemodynamics were noted. He was induced with sevoflurane 5% which was subsequently dialled down to 1.5%. A 24 G IV cannula was inserted on right hand dorsum and 15 mcg fentanyl and 5mg atracurium were administered. After ventilating with 100% Oxygen for 3 minutes, trachea was intubated with uncuffed portex endotracheal tube of size 4.5 and fixed at 8cms after confirming equal air entry in bilateral lung fields. A throat pack was inserted to reduce leak around the tube, which was removed at the end of the surgery prior to extubation.

Atracurium was administered as an IV infusion at the rate of 2 mg/hr. Anaesthesia was maintained with 1.5% sevoflurane in a 2:2 nitrous:oxygen mixture using Intermittent Positive Pressure Ventilation (IPPV). Using ultrasound guidance, a single lumen 22G CVC was inserted in the right femoral vein under strict asepsis. Right radial arterial line was set up using a 22G cannula. IV fluid Icolyte-P was administered as 32ml/hr for the first hour and 64ml/hr for the next 2 hours. Paracetamol 250 mg suppository was inserted for analgesia. Other IV medications given include ondansetron 0.8mg and tranexamic acid 80mg. $ETCO_2$ throughout the surgery was maintained between 30 and 32 mmHg.

A body warmer was placed for maintaining normothermia.

Duration of the surgery was 3 hours. Total blood loss was approximately 80ml. To make up for the surgical blood loss, 100 ml of cross matched packed cells were transfused. No transfusion related complications were seen. Urine output in the intraoperative period was about 30ml/hr and there was no change in colour of urine. Intraoperative Glucometer Random Blood Sugar (GRBS) was noted to be 118mg/dl. Haemodynamics were maintained stable throughout the surgery. Arterial Blood Gas (ABG) was done twice; at the start of the surgery and at completion of surgery and were found to be within normal limits (Table 1). Lactate and GRBS levels were also normal.

At the completion of surgery, residual neuromuscular blockade was reversed with 0.4 mg neostigmine and 0.08mg glycopyrrolate IV and the patient was extubated once fully awake. He was monitored in the post-operative ward for 2 hours and after ruling out signs of acute haemolysis such as dark urine, irritability, hypotension etc he was subsequently shifted to the Paediatric ICU for further monitoring. The day after surgery, Hb level was

Table 1. Arterial blood gas analysis intraoperatively on IPPV with FiO2 0.5

	At the start of surgery	Prior to extubation
pH	7.34	7.42
pO_2	129	249
pCO_2	42	36
Na^{2+}/K^{+}	131/4.0	129/4.9
Lactate	2.7	3.3
HCO_3^-	25.6	23.4
sO_2	99	100

investigated and was found to be 9.8 g/dl. Additional tests to check for haemolysis were not performed as there were no signs of haemolysis. Postoperative pain was controlled using oral paracetamol syrup. He was discharged 10 days post-surgery after confirming no evidence of delayed haemolysis.

3. Discussion

In G6PD deficiency patients, it is generally noticed that drug-induced haemolysis may occur anywhere between 24 and 72 hours following drug administration. In our patient anaesthetic management was focused on avoiding oxidative stress and the drugs implicated in haemolysis were strictly avoided to prevent perioperative haemolysis.

According to literature, most anaesthetic agents are considered safe in G-6-PD deficiency[5,6]. There is evidence that sevoflurane is safe for use in G6PD-deficient patients[7]. In our patient we used agents like sevoflurane, fentanyl and atracurium and no adverse effects were noted.

Surgical stress by itself is known to cause haemolysis and can be masked by general anaesthesia. Hence, liberal analgesia and anxiolysis in the perioperative period is recommended[8]. In this case, fentanyl (2 mcg/kg) and paracetamol (30mg/kg per rectally) were used for analgesia and anxiolysis.

Similarly, Dogra *et al.*[1] have reported that liberal anxiolysis and adequate depth of anaesthesia, stable haemodynamics, and maintenance of normothermia, normal blood pH and blood sugar helps to prevent haemolysis[9].

Hypotension is a non-specific indicator of the acute haemolytic crisis and may not be identified till haematuria is observed[10]. In this case, we inserted an arterial catheter for better monitoring of blood pressure throughout the surgery and maintained blood volume with IV fluids calculated according to weight. In addition, blood was transfused to make up for surgical loss. During the intraoperative period, End Tidal Carbondioxide ($ETCO_2$) was maintained at 30–32 mmHg, blood gas analyses were done at the start and end of the surgery and all parameters were maintained in the normal range. Infection being another factor known to aggravate haemolysis[11] Cefuroxime (500 mg) was administered as a prophylactic antibiotic.

G-6-PD deficiency poses a risk of life-threatening haemolysis which can lead to neurological damage, anuria and acute renal failure. Laboratory findings including anaemia, reticulocytosis and derangement of liver and renal function parameters may be seen in haemolysis. In our patient haemoglobin level evaluated on post-operative Day 1 was found to be 9.8g/dL and none of the symptoms such as fatigue, headache, abdominal pain, scleral icterus or dark urine which are pointers of haemolysis were seen[12,13]. Hence, the absence of such physical symptoms or changes in activity of the infant did not necessitate further laboratory investigations.

4. Conclusion

In a case of G6PD deficiency, challenges in anaesthetic management include avoiding oxidative stress (induced by certain drugs or physiological changes), and monitoring for hypercapnia, which can cause acidosis and haemolysis. In our patient, adequate depth of anaesthesia was maintained, carbon dioxide retention was avoided, and normothermia and all other blood parameters were strictly maintained in the normal range. Thus, both acute and delayed haemolysis was successfully avoided in this case. Our experience also suggests safety of use of sevoflurane, fentanyl, propofol and atracurium in G6PD deficient patients.

5. Conflicts of Interest

None.

6. References

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