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CASE REPORT

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Subarachnoid block in an eight-month old infant with glucose-6-phosphate dehydrogenase deficiency

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Abstract: Glucose-6-Phosphate Dehydrogenase (G6PD) deficiency is a clinical condition characterized by red blood cell enzymatic defect resulting in haemolysis following exposure to oxidative stress from medications and infections. Some of the drugs used in anaesthesia and peri-operative pain management may also induce haemolysis in individuals who are G6PD deficient.
In this report, an eight-month-old boy with G6PD deficiency who had bilateral herniotomy under spinal anaesthesia without untoward events is described. Intra-operative and postoperative courses were uneventful as there were no haemolytic complications, malignant hyperthermia nor methaemoglobinaemia.
The focus of anaesthetic management in this child was avoiding drugs which may cause haemolysis in G6PD deficiency, reducing surgical stress with adequate analgesia, and adequate preparations to manage haemolysis should it occur. Therefore, it is recommended that subarachnoid block with heavy bupivacaine can be performed safely, particularly for individuals with G6PD deficiency in place of general anaesthesia.

Keywords: Glucose-6-Phosphate dehydrogenase Deficiency, haemolysis, infancy, subarachnoid block

Introduction

Glucose-6-Phosphate Dehydrogenase (G6PD) deficiency is the most common enzymatic disorder of red blood cells in humans. [1, 2] It is estimated that about 400 million people are affected by this disorder but there is a dearth of data on special anaesthetic considerations for individuals with G6PD deficiency, given the likelihood of some anaesthetic agents precipitating haemolysis in G6PD deficiency. [1, 2]

This X-linked inherited disorder has the highest prevalence in Africa, southern Europe, Middle East, Southeast Asia as well as the central and southern Pacific islands. [1,2] Also, the disorder is known world-wide. [3] Due to the pattern of inheritance, there is a higher incidence among males compared to females.[4]
Individuals with G6PD deficiency can be asymptomatic or symptomatic depending on the severity of the enzyme deficiency. Although, both the homozygotes and the heterozygotes may be symptomatic, the disease is typically more severe among homozygous individuals. [2]
Glucose-6-Phosphate Dehydrogenase enzyme catalyzes the first step in the pentose phosphate pathway in glucose metabolism and produces ions which act as antioxidants protecting red blood cells against oxidative stress damage.[5] The activity of this enzyme is an exclusive source of an antioxidant; Nicotinamide Adenine Dinucleotide Phosphate (NADPH) in red blood cells. The most important role of NADPH in erythrocytes is the regeneration of reduced glutathione, which prevents hemoglobin denaturation in the face of oxidative stress, preserves the integrity of the red blood cell membrane sulfhydryl group and detoxifies peroxides and oxygen free radicals in the red blood cells. NADPH is reduced in patients with G6PD deficiency.[2]
G6PD deficiency typically presents with acute haemolysis and hyperbilirubinaemia. [2,4] Different gene mutations cause different levels of enzyme deficiency, with classes assigned to various degrees of deficiency and disease manifestations.[2, 3]

The prevention of acute haemolysis is pivoted on the avoidance of exposure to oxidative stressors in the form of infections, oxidative anaesthetic drugs such as lidocaine, paracetamol (acetaminophen), benzocaine and other medications such as sulphonamides, quinine, acetylsalicylic acid, and methylene blue.[2,3, 6] Acute haemolysis is usually self-limited, but in rare instances it may be severe enough to warrant blood transfusion.[2,3,7]
The variant of this disorder which causes chronic hemolysis is uncommon because it is related to sporadic gene mutation rather than the more common inherited gene mutation.[2,3]

The most effective anaesthetic management strategy in G6PD deficiency is the prevention of haemolysis by avoiding oxidative stressors. Also, the management of pain and anxiety should include medications that are safe and not known to precipitate haemolysis such as benzodiazepines, codeine and codeine derivatives, propofol, paracetamol, inhalational agents, fentanyl and ketamine.
In this report, we demonstrate the successful use of subarachnoid block in providing safe and effective anaesthesia and postoperative analgesia in an infant with G6PD deficiency.[8,9]

Case Report

A two-month-old boy presented at the Paediatric Surgical Out-patient Clinic (PSOP) of Olabisi Onabanjo University Teaching Hospital, Sagamu on the 19th December 2016 on account of the bilateral groin and umbilical swelling noticed from birth. Following the evaluation, diagnoses of reducible umbilical hernia and bilateral reducible inguinoscrotal hernia were made. The mother was counseled about the condition and the treatment plan. The mother defaulted from the clinic for six months and thereafter re-presented for surgery when the baby was eight months old. The boy was scheduled for bilateral herniotomy and he was to have umbilical herniorrhaphy later. The pre-anaesthesia review showed that the mother booked for antenatal care at the same health facility at an estimated gestational age of 12 weeks, had two doses of Tetanus toxoids and a pelvic ultrasound scan which revealed no fetal abnormality, among other prenatal care. The baby was delivered at term in a Maternity Health Centre spontaneously vertex and there were no postnatal complications.

The baby was exclusively breastfed and appropriately commenced on a complementary diet. He was fully immunized for age and the development had been normal. There was a history of neonatal jaundice following exposure to an icterogen (eucalyptus oil) when he was eight days old hence he was diagnosed by the quantitative method of G6PD assay to be G6PD deficient. He was managed with phototherapy and double volume exchange blood transfusion at this same facility. Following discharge at the age of one month, the mother was counseled to avoid common trigger factors for G6PD deficiency haemolysis.

The mother was a 24-year old secondary school certificate holder and a hairdresser, with blood group O-Rhesus-positive and haemoglobin genotype AS. The father was a 29-year old secondary school certificate holder and a local fuel station attendant, belonging to O Rhesus--positive blood group and haemoglobin genotype AA. The index patient was the second child in a monogamous family of two children. There was no history of neonatal jaundice or inguinoscrotal swelling in the older sibling.
General examination of this patient revealed a healthy-looking male infant weighing 8kg. he was not pale, anicteric, afebrile (37.50 C), acyanosed and well hydrated. The systemic examinations revealed no abnormality.
The airway was assessed to determine the ease of intubation and this revealed milk sets of teeth with no features limiting neck mobility. Therefore, the child was graded ASA I according to the American Society of Anesthesiologist classification of physical health status. The results of initial laboratory investigations for planned herniotomy revealed a Packed Cell Volume of 30%, normal blood parameters, normal serum electrolytes, urea and creatinine, and normal urinary profile.
The anaesthetic plan and technique were discussed with the parents highlighting the risks of general anaesthesia compared to regional anaesthesia.

The routine pre-operative plans were adhered to and informed consent for surgery and anaesthesia was obtained from the parents. Following pre-anaesthetic machine checklist, the child was positioned appropriately and using the multiparameter monitor, the initial vital signs were as follows: heart rate [92 beats/minute], arterial oxygen saturation (SpO2) - [99%], respiratory rate - [45cycles/minute], body temperature - [37.30C] and normal electrocardiographic measurements. Using a 22-Gauge cannula, 4.3% Dextrose in 0.18% Saline was infused. The child was pre-medicated with intravenous atropine 0.1mg/kg and intravenous 0.25mg/kg dexamethasone. A sleeping dose of ketamine (1mg/kg) was administered intravenously and 100% Oxygen was administered at the rate of 3Litre/minute via a nasal cannula. The position was changed from supine to left lateral decubitus. The head and both lower limbs were gently abducted by anaesthetist attendant and the landmarks for the subarachnoid space were identified. Following an aseptic protocol, the subarachnoid block was established after the free flow of cerebrospinal fluid using 0.4mg/kg body weight of 0.5% hyperbaric bupivacaine at interspinal space L4/L5, using 27-Gauge Whitachre spinal needle at a depth of 2.5cm from the skin surface.

The child was gently re-positioned supine, in horizontal position and vital signs monitored closely. The level of sensory block was assessed to be T6 and this was maintained till the end of surgery. The child had oxygen by face mask throughout the period of surgery.
The following measures were taken to avoid precipitation of haemolysis in this child. It was ensured that clothings were not preserved with naphthalene balls, and methylated spirit was not included in the solution used to prepare the skin. Furthermore, the child was kept warm by switching off the air-conditioning system in the operating room and covering the exposed part of the body with warm gauze padding.
Skin infiltration with 1ml of 1% Lidocaine was not needful because the subarachnoid block was effective. Therefore, another agent which can precipitate hemolytic crisis was avoided.
Liberal hydration was done peri-operatively with intravenous fluids given at the rate of 4mls/kg body weight. The surgery lasted for fifty-seven minutes. The total amount of crystalloid administered was 250ml while the estimated blood loss was less than 10mls.
The child was kept warm and transferred to the Post-

anaesthetic Recovery Unit without pain or other complains, for continuous monitoring of vital signs and oxygen supplement via a non-rebreathing face mask at 3Litre/minute. He was kept there for sixty minutes without any medications and was, thereafter, transferred to the Paediatric Surgical Ward in a stable clinical state (SpO2- 100%, heart rate 110beats/minute). Oral feeding was allowed after six hours post-operative period and the child was discharged home the following day after surgery with no complication. The postoperative analgesic agent prescribed was acetaminophen 100mg 6-hourly for 24 hours but no episode of haemolysis was reported during follow-up at home via telephone calls and during the short postoperative follow-up visit.

The parents of the child were taught to look out for signs and symptoms of haemolysis (difficulty in breathing, fatigue, yellowish discoloration of eyes and skin and passage of dark brown urine) and to avoid all the icterogens which were listed out on a piece of paper as part of take-home instructions.

Discussion

Sub-arachnoid block (SAB) with heavy bupivacaine was the preferred anaesthetic technique in the index child because the procedure was carried out below the umbilical level. It also allowed for minimal use of drugs (0.5% hyperbaric bupivacaine) unlike in general anaesthesia, where poly-pharmacy may be required to achieve effective anaesthesia. Therefore, the risk of drug-induced haemolysis was minimized. Although, studies have shown that regional anaesthesia technique is a safe alternative to general anaesthesia, the use of lignocaine is strongly prohibited because it predisposes to hemolysis. Meanwhile, few case reports have mentioned the use of bupivacaine.[10] Also, SAB can help to reduce intra-operative blood loss and could serve in post-operative pain relief in the immediate postoperative period. The observation in this report agreed with the findings of Kokki *et al*[11] as the child maintained satisfactory cardiovascular functions during the period of subarachnoid block.

The Full Blood Count showed no active infection in the child before anaesthesia and surgery. During active infections, oxygen free radicals are produced either by inflammatory neutrophils or following the use of antimicrobials and the free radicals are known to precipitate haemolysis.[12] This underscores the importance of adequate treatment of active infections before surgery among G6PD deficient individuals. The use of drugs such as lidocaine and acetylsalicylic acid was also avoided since they are known to precipitate haemolysis in G6PD deficiency. It is important to note that, the child had adequate analgesia and anxiolytic therapy in the peri-operative period and that contributed to an uneventful anaesthetic course.

Subarachnoid block is an effective alternative to general anaesthesia technique for children with G6PD deficiency, as it prevents exposure to potential oxidative stressors and consequent haemolysis. Also, the management of post-operative pain and anxiety should include medications that have not been shown to cause haemolysis such as benzodiazepines, codeine /codeine derivatives, propofol, fentanyl, and ketamine.

Conclusion

Subarachnoid block is a safe and effective alternative to general anaesthesia for G6PD deficient children scheduled for surgical procedures below the umbilical level in whom the choices of drugs may be limited.

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