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PERIOPERATIVE MANAGEMENT OF A CASE OF LIVER TRANSPLANTATION WITH GLYCOGEN STORAGE DISEASE 1-A

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ABSTRACT Glycogen storage diseases (GSDs) refer to a group of inherited disorders caused by the absence of essential enzymes in the synthesis or degradation of glycogen leading to abnormal concentration and/or structure of glycogen in body tissues.GSDs of type I, III, IV, VI, and IX show liver involvement and are considered for liver transplantation as liver transplantation corrects the primary hepatic enzyme defect. Glycogen storage disease type I is an inborn error of carbohydrate metabolism caused by defects in the glucose-6-transporter/glucose-6-phosphatase complex which is essential in glucose homeostasis. The peri-operative management of glycogen storage disease for liver transplantation needs correction of metabolic, synthetic, coagulation and glycemic dysfunction. **Case Presentation:** We present the case of a 8-year-old male patient with reccurent episodes of low blood sugar and bleeding from the nose, high serum triglycerides and a protruding abdomen with stunted growth, planned for liver transplantation after being diagnosed as glycogen storage disease - Ia on genetic sequencing. Ultrasound abdomen revealed Hepatomegaly (15 cms) with coarse echotexture and bilateral nephromegaly. Liver Fibroscan revealed liver fibrosis- F3 and MRI abdomen revealed hepatomegaly with hepatocellular hyperplastic lesions on the inferior margin of the right lobe and diffuse T2W hypointensity with bridging septations. This final diagnosis was GSD-Ia with reccurent hypoglycaemia, epistaxis and bilateral nephromegaly who underwent living-donor liver transplantation and recovered well without any complications till 6months of the surgery. **Conclusion:** The paediatric age group presenting with hepatomegaly, hypoglycaemia, epistaxis, growth retardation and laboratory test abnormalities, including high serum triglycerides, hyperuricaemia, and hypoglycaemia with low or normal platelets and coagulation profile shouldbe screened out for a diagnosis of GSD. Liver transplantation and major surgeries involving vascular anastomosis require special attention apart from metabolic control.

KEYWORDS : Coagulopathy, Glycogen Storage Disease, Growth Retardation, Hypoglycaemia, Liver Transplantation.

INTRODUCTION

Glycogen storage disease type 1a (GSD-1a) is a rare autosomal recessive inborn error of metabolism caused by deficient activity of G6Pase which converts glucose 6 phosphate to glucose[1]. In GSD 1a, endogenous glucose production is impaired by defects in both glycogenolysis and gluconeogenesis [2]. Clinically the patients present mainly in the paediatric age group with reccurent hypoglycemia, hyperuricaemia, hypertriglyceridemia, resistant lactic acidosis, short stature with a protruding abdomen. This case presented with recurrent hypoglycemia, epistaxis and hepatomegaly and underwent an orthotopic Liver Transplant.

Case Presentation

A 8-year-old, 20 kgs male child with AB+ blood group, diagnosed with GSD-1a came to the emergency early in the morning with epistaxis and was found to be hypoglycemic (glucose- 62mg/dl). He was investigated and found to have the following results as described in table-1.

Blood group	AB positive
Hemoglobin	7.8
Total Leucocyte Count	4560
Platelet count	356000
INR	0.92
APTT	28
Fibrinogen	211
Creatinine	0.24
Na/K	137/36
Bilirubin	1.58
SGOT/SGPT	125/70
Protein/Albumin	7.2/4
Triglycerides	618
Glucose	65
Lactate/ Bicarbonate	4.6/23

On close monitoring of the patient, the serial random blood sugar was found to be mostly between 50-80 mg/dl and lactate after adequate resuscitation was found to be in the range of 2.8- 4.6. The hemoglobin was found to be around 7.2- 8.4 g/dl and serum triglyceride was 360 mg/dl. ECHO, ECG and Chest Xray were normal. The patient was admitted for metabolic control and resistant lactic acidosis 2 days before the surgery. The PELD score was 0 and CTP score was 5. After admission the patient was put upon the GSD protocol for perioperative normoglycemia and metabolic control as described below :

Glycogen storage disease guidelines for the patient-

1. Avoid fasting for more than 3-4 hours
2. Small, frequent meals with no added sugars
3. Avoid sucrose, fructose, galactose, monosaccharides or disaccharides.
4. Monitor blood glucose 2-4th hourly while fasting or 4-6th hourly when taking orally.
5. Target CBG > 80 mg/dl (preferably 80-150 mg/dl)
6. IVF with 10% dextrose with 0.45 NaCl at 3-4 ml/kg/hr
7. Glucose requirement- 4 to 8mg/kg/hr or 3-4 ml/kg/hr
8. Optimization of Electrolytes and micro nutrients
9. Prevention of Lactic acidosis
10. Prevention and treatment of Bleeding

The patient was posted for liver transplantation and was fasted for 4 hours before the surgery to prevent hypoglycemia. An infusion was started with dextrose 10% at 60ml/hr and 2nd hourly blood glucose was monitored and blood glucose was maintained between 80 -150 mg/dl. The Pre-operative urine output was targeted at 1ml/kg/hr and the baseline lactate was 2.9. The patient was shifted to the OT and intubated under General anesthesia. A radial and a femoral arterial line were cannulated, right internal jugular vein cannulation was done with a 5.5 Fr triple lumen central line and a 4.5 fr triple lumen central line catheter. The patient was maintained under general anaesthesia using the GSD protocol.

The Targets of Intra-operative Management were -

Table 1: Intra-operative Targets in for Management in GSD

Temperature	36 - 37.5 ° C
Blood sugar	80-150 mg/dl
Urine output	1ml/kg/hr
Mean Arterial Pressure	65-75 mmHg
CVP	0-8 cm H20
Heart Rate	60-120/ min
Hemoglobin	8-9 g%

DISCUSSION

Glycogen storage disease- I or von Gierke disease or hepatorenal glycogenosis was first described by Gierke in 1929 based on autopsy results showing excessive glycogen storage in the livers and kidneys.These abnormalities are mainly related to a defect of either glucose-6-phosphatase or glucose-6-phosphatase transporter, which impairs the production of glucose via either gluconeogenesis or glycogenosis that lead to abnormal concentrations or structures of glycogen [3]. The deficiency of Glucose-6-phosphatase causes GSD-1a and that of Glucose-6-phosphatase transporter causes GSD-1b.

The onset of clinical symptoms might start as soon as after birth or

during infancy and include apnea, cyanosis, poor feeding, tremors, pallor, excessive sweating, hyperventilation, irritability, seizures, somnolence,cerebral edema, ketotic hypoglycemia,coma and sudden infant death.

Older children manifest growth retardation with a protuberant abdomen due to hepatomegaly and nephromegaly, a doll-like facies with fullness of the cheeks, relatively thin extremities, frequent lethargy, difficulty in waking from sleep, tremors, an insatiable appetite, xanthomas on the extensor surfaces like elbows, knees, or buttocks, bleeding from gums and nose etc.

Patients with type I are at increased risk for perioperative metabolic and homeostatic derangements mainly hypoglycemia unresponsive to glucagon therapy and lactic acidosis. As fasting hypoglycemia is the most important problem of the disease, a short duration of preoperative fasting is recommended for such patients. We offered 4 hours fasting to our patient and started an infusion of Dextrose10% at 60ml/hr. A glucose infusion rate of 8-10 mg/kg/min should be maintained for infants, while a rate of 4-8 mg/kg/min is recommended for older children. Frequent monitoring of blood glucose is recommended during the perioperative period . We measured the serum glucose level every 6th hourly while taking oral diet and 4th hourly when nil per orally.

On a daily basis, the recommended dietary plan is to provide 60%-70% of calories from complex carbohydrates, such as whole-grain breads, pastas, legumes, and rice, with a portion of the carbohydrates coming from cornstarch and 10%-15% of calories should come from protein and 25%-30% from fat [4].

Liver Transplantation resolves the hepatic manifestations of GSD but the extra-hepatic symptoms of the disease might however persist. The most common extrahepatic complication in GSD-1a is renal failure and in GSD-1b is Neutopenia [5] .The most common indication for liver transplantation in GSD I has been hepatic adenomatous disease for removal of potentially premalignant lesions. Other indications have included growth failure and poor metabolic control.

Patients with type I are also at risk for the development of pancreatitis secondary to hypertriglyceridemia [6]. Both neutopenia and hypertriglyceridemia dispose kids to the risk of infections. The use of higher antibiotics at the right dosages and frequency is the key to prevent and treat the infections. Antibiotics covering broad spectrum of organisms including anerobes and MRSA are to be used. Propofol must be administered cautiously. Post operative serum triglycerides were monitored.

The kid came to the hospital with active bleeding from the nose inspite of a normal platelet count mainly caused by a defect in platelet aggregation or von Willebrandfactor. The risk of bleeding is increased in GSD population by a defect in platelet aggregation upto 23% of GSD-I patients. The impaired platelet function in individuals with inadequate metabolic control predisposes patients to nose bleeding. Diminished glucose uptake into platelets due to chronic hypoglycemia and subsequent intracellular ATP deficiency have been proposed as potential causes of platelet dysfunction in GSD-Ia [7].

Patient with GDS type I may also have coagulation abnormalities arising from acquired von Willebrand factor abnormalities, and the perioperative use of desmopressin advocated to facilitate hemostasis[8]. However we didn't require the use of desmopressin to treat epistaxis.

There can be difficulties in intubation due to short and thick neck and difficulties of mask ventilation due to macroglossy in the GSD patients [9].As the intraabdominal pressure is elevated in these patients due to their organomegaly and truncal obesity, they are more prone to gastroesophageal reflux and aspiration and hence the NPO hours should be strictly monitored and if feasible, cricoid pressure can be applied. In our case there was palpable hepatomegaly and hence we induced the kid using sellick's maneuver making sure that no cartilage is being injured and there is no active bucking or laryngospasm.

A volume of 300 ml of LDPRBC was transfused during the entire surgery with no requirement of blood products.Though the urine output was adequate and there was no hypothermia, lactic acidosis escalated from 4.6 to 8.2 till the neohepatic phase. There were two instances of intra-operative hypoglycaemia, one in the dissection phase (Glucose- 68) and one in the anhepatic phase (glucose - 65). Both of the instances of hypoglycemia were treated with iv dextrose 25% .

Table 2: Serial ABG Analysis During the Intra-operative Period.

Time	Induction	2hrs	5hrs	8hrs	10hrs	12hrs	13hrs
PH	7.35	7.33	7.34	7.32	7.34	7.28	7.36
PaO2	188	176	180	156	214	152	176
HCO3	22.8	20.6	21.2	18.4	21.5	20.3	22.6
BE	-2.2	-4.4	-3.8	-6.8	-4.2	-5.7	-2.2
Lactate	3.75	4.3	4.7	6.2	8.2	7.9	6.4
Glucose	102	132	68	112	65	144	156
Hb	7.6	7.8	6.9	8.2	7.4	8.5	8.2
Na/K	138/4.1	139/3.8	137/3.9	140/4.1	142/3.9	140/3.8	139/3.6

There is inherent arterial wall thickening in GSD- I , which can lead to Hepatic artery thrombosis if there is any hemoconcentration, stasis or intimal injury leading to graft dysfunction and death.So, the target hemoglobin was kept within 8-9 g% and anticoagulant was started from post-operative day 3.

There was no other anaesthetic or surgical event during the intra-operative period and the patient was shifted to the icu on ventilator with a Hb 8.2 of and lactate of 6.4.The INR was maintained between 1.5-2.5 and Hemoglobin was kept between 7.5- 9 in the first week post transplant. Anticoagulation was maintained with the help of Inj Heparin and Clexane. The patient was treated in the post transplant period by the paediatric intensivists, gastroenterologist and was discharged on post operative day 11th without any complications.

CONCLUSION

Glycogen storage disease-I is an autosomal recessive disease affecting multiple systems of the body and presenting mainly as hypoglycaemia, recurrent lactic acidosis, seizures, bleeding mainly epistaxis and organomegaly eventually leading to organ failure. Most of the patients present mainly in childhood and the perioperative management has to focus on metabolic homeostasis by adequate glucose supply, prevention of lactate acidosis exacerbation, prevention of infections due to neutropenia and treatment of bleeding disorders due to platelet dysfunction. The main issues of patients with GSD-I undergoing long duration surgeries are recurrent hypoglycaemia, aggravating lactic acidosis, coagulopathy and electrolyte imbalance. Proper pre-operative assessment and intra-operative vigilance and immediate intervention are the cornerstone of management in patients with glycogen storage diseases.

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REFERENCES

1. Froissart R, Piraud M, Boudjemline AM, Vianey-Saban C, Petit F, Hubert-Buron A, Eberschweiler PT, Gajdos V, Labrune P. Glucose-6-phosphatase deficiency. Orphanet J Rare Dis. 2011 May 20;6:27. doi: 10.1186/1750-1172-6-27. PMID: 21599942; PMCID: PMC3118311.
2. Wilke MVMB, de Kleine RH, Wietasch JKG, et al. Orthotopic Liver Transplantation in Glycogen Storage Disease Type 1a: Perioperative Glucose and Lactate Homeostasis. Journal of Inborn Errors of Metabolism and Screening. 2016;4. doi:10.1177/2326409816649599
3. Gurrieri C, Sprung J, Weingarten TN, Warner ME. Patients with glycogen storage diseases undergoing anesthesia: a case series. BMC Anesthesiol. 2017 Oct 6;17(1):134. doi: 10.1186/s12871-017-0428-x. PMID: 28985713; PMCID: PMC5639598.
4. Gümüş E, Özen H. Glycogen storage diseases: An update. World J Gastroenterol. 2023 Jul 7;29(25):3932-3963. doi: 10.3748/wjg.v29.i25.3932. PMID: 37476587; PMCID: PMC10354582.
5. Boers, S.J., Visser, G., Smit, P.G. et al. Liver transplantation in glycogen storage disease type I. Orphanet J Rare Dis 9, 47 (2014). https://doi.org/10.1186/1750-1172-9-47.
6. Derks TG, van Rijn M. Lipids in hepatic glycogen storage diseases: pathophysiology, monitoring of dietary management and future directions. J Inherit Metab Dis. 2015 May;38(3):537-43. doi: 10.1007/s10545-015-9811-2. Epub 2015 Jan 30. PMID: 25633903; PMCID: PMC4432100.
7. Hutton RA, Macnab AJ, Rivers RP. Defect of platelet function associated with chronic hypoglycaemia. Arch Dis Child. 1976 Jan;51(1):49-55. doi: 10.1136/adc.51.1.49. PMID: 942229; PMCID: PMC1545862.
8. Mühlhausen C, Schneppenheim R, Budde U, Merkel M, Muschol N, Ullrich K, Santer R. Decreased plasma concentration of von Willebrand factor antigen (VWF:Ag) in patients with glycogen storage disease type Ia. J Inherit Metab Dis. 2005;28(6):945-50. doi: 10.1007/s10545-005-0184-9. PMID: 16435187.
9. Mohart D, Russo P, Tobias JD. Perioperative management of a child with glycogen storage disease type III undergoing cardiopulmonary bypass and repair of an atrial septal defect. Paediatr Anaesth 2002; 12: 649-54