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Sumnil Marwaha

Department of Veterinary
Medicine, Lala Lajpat Rai
University of Veterinary and
Animal Sciences, Hisar,
Haryana, India

Ricky Jhambh

Department of Veterinary
Medicine, Lala Lajpat Rai
University of Veterinary and
Animal Sciences, Hisar,
Haryana, India

Vinod Kumar Jain

Department of Veterinary
Medicine, Lala Lajpat Rai
University of Veterinary and
Animal Sciences, Hisar,
Haryana, India

Rachna Poonia

Ph.D., Department of Veterinary
Pathology, RAJUVAS, Bikaner,
Rajasthan, India

Clinico-diagnostic investigation on hyperglycemia in dairy buffaloes

Sumnil Marwaha, Ricky Jhambh, Vinod Kumar Jain and Rachna Poonia

Abstract

Hyperglycemia or elevated glucose level is important condition of imbalanced glucose metabolism. It can occur in various clinical conditions even in absence of diabetes. Therefore, the present study was conducted on hyperglycemic buffaloes presented to the Medicine Section of Veterinary Clinical Complex, LUVAS, Hisar from 1st November, 2018 to 15th January, 2019 for various clinical affections and were characterized as per the primary disease condition diagnosed. There were total 24 buffaloes in which there was hyperglycemia. The study showed that hyperglycemia in these buffaloes was concurrent mainly with pneumonia, diaphragmatic hernia and traumatic reticuloperitonitis. The blood glucose concentrations measured through automated clinical chemistry analyzer in these cases ranged from 78.9-275.0 mg/dl with mean value of 150.22±10.15 mg/dl. Thus, the determination of glucose levels in clinical case is important and the use of corticosteroid and glucose infusions in cases with hyperglycemia must be judicious.

Keywords: Hyperglycemia, glycosuria, buffaloes, insulin therapy

Introduction

Glucose is the most important nutrient in all mammals, being the main source of energy. In ruminants, the main source of glucose is gluconeogenesis from volatile fatty acids (propionate) absorbed from rumen by bacterial fermentation. Metabolism of glucose in body depends on number of factors including insulin, glucagon, growth hormone, catecholamine and cortisol. Hyperglycemia or elevated glucose level is important condition of imbalanced glucose metabolism. It is seen in diabetes mellitus or in stress induced conditions. Diabetes mellitus has been reported from cattle, pigs, sheep, horses, and bison; but has very little incidence in buffaloes (Clark, 2003) [3]. Type II diabetes has been reported in cattle and buffaloes. It is most commonly associated with mainly infectious and metabolic diseases such as fatty liver, fat cow syndrome (Nazifi *et al.* 2004) [15], parturition and chronic insulinitis, as well as viral diseases, especially bovine virus diarrhea (Tajima *et al.*, 1999) [21], Foot and mouth disease (Ghanem and Hamid, 2010) [6] and protozoal diseases such as trypanosomiasis (Singh *et al.*, 2018) [20]. Hyperglycemia can occur in various clinical conditions even in absence of diabetes. It is generally transient increase in blood glucose levels that will return to normal when stress of clinical condition is removed. In medical science, this condition is termed as extreme stress hyperglycemia. This stress hyperglycemia occurs due to high levels of various hormones which stimulate glycogenolysis and gluconeogenesis namely cortisol, glucagon, growth hormone, catecholamines and various cytokines (Weiss *et al.*, 2010) [24]. Hyperglycemia in infectious disease is mainly due to increased cortisol levels but some diseases like foot and mouth disease, bovine viral diarrhea and fatty liver can affect beta cells of pancreas leading to the development of diabetes. Thus, such cases should be analyzed to differentiate from extreme stress hyperglycemia. Thus, the determination of glucose levels in clinical case is important and the use of corticosteroid and glucose infusions in cases with hyperglycemia must be judicious. The present study involved the blood glucose level analysis in various clinical cases of buffaloes with respect to their disease, history and use of corticosteroids.

Material and Methods

The present study was conducted on hyperglycemic buffaloes presented to the Medicine Section of Veterinary Clinical Complex, LUVAS, Hisar from 1st November, 2018 to 15th January, 2019 for various clinical affections. The detailed clinical history along with previous history was collected from the owner, followed by complete clinical examination and ancillary testing as per the clinical condition of the animal.

Corresponding Author

Sumnil Marwaha

Department of Veterinary
Medicine, Lala Lajpat Rai
University of Veterinary and
Animal Sciences, Hisar,
Haryana, India

The blood glucose concentrations was measured in serum samples using automated random access clinical chemistry analyzer (EM Destiny 180, Erba Diagnostics Mannheim GmbH). Urinalysis was performed for presence of glucose using urine test strip. The hyperglycemic cases were characterized as per the primary disease condition diagnosed and were correlated with possible etiological factors. The normal serum glucose levels were considered to be 48-73 mg/dl.

Results and Discussion

A total of 24 dairy buffaloes were diagnosed for hyperglycemia and were characterized as per the primary disease condition. Among these 24 buffaloes, there were 10 disease conditions that were characterized *viz.*, pneumonia, diaphragmatic hernia, foreign body syndrome/traumatic reticuloperitonitis (TRP/FBS), renal insufficiency, urinary tract infections, mastitis, mastitis with otitis, hydrothorax, enteritis and impaction. The data is represented in table 1.

Table 1: Etiological characterization of hyperglycemic cases in buffaloes

Sr. No.	Disease	No. of animal	Hyperglycemia	Hyperglycemia with glycosuria	Hyperglycemia without glycosuria	Only glycosuria
1	Pneumonia	3	(3/3)	(2/3)	(1/3)	0
2	Diaphragmatic hernia	3	(3/3)	(3/3)	(0/3)	0
3	TRP/FBS	5	(5/5)	(4/5)	(1/5)	0
4	Renal insufficiency	3	(3/3)	(3/3)	(0/3)	0
5	UTI	2	(2/2)	(0/2)	(2/2)	0
6	Mastitis	1	(1/1)	(1/1)	(0/1)	0
7	Mastitis + Otitis	1	(1/1)	(1/1)	(0/1)	0
8	Hydrothorax	2	(2/2)	(2/2)	(0/2)	0
9	Enteritis	2	(2/2)	(1/2)	(1/2)	0
10	Impaction	2	(2/2)	(0/0)	(2/2)	0
	Total	24	(24/24)	(17/24)	(7/24)	0

Blood glucose concentrations ranged from 78.9-275.0 mg/dl with median value of 145mg/dl and mean value of 150.22±10.15 mg/dl. The average glucose levels in various diseases are shown in table 2. The highest blood glucose value for which glycosuria didn't occur was 110.8 mg/dl. The reported renal threshold for glucose in cattle is 100.01 mg/dl (Liu *et al.*, 2004) [12]. The highest mean glucose level was found in cases of diaphragmatic hernia while the lowest mean glucose value was in impaction. The reason of the particular finding may be that the stress induced in diaphragmatic hernia is usually higher than that in impaction.

Table 2: The mean glucose (mg/dl) values in various diseases

S. No.	Disease	Blood glucose value (mg/dl)
1	Pneumonia	148.0467±26.09
2	Diaphragmatic hernia	210.03±16.72
3	TRP/FBS	140.16±12.81
4	Renal insufficiency	164.43±55.61
5	UTI	101.65±3.25
6	Mastitis	119.80±0.00
7	Mastitis + Otitis	196.00±0.00
8	Hydrothorax	154.00±38.01
9	Enteritis	106.07±25.7
10	Impaction	94.85±15.95

The highest number of cases was reported for TRP/FBS. The reason may be due to the reason that the prevalence of TRP/FBS is more and the stress levels are higher in this disease. Among other gastrointestinal diseases were impaction, enteritis and diaphragmatic hernia. Glucose level in impaction was 94.85±15.95 which is similar to that reported by Hussain and Uppal (2012) [9] and Wittek *et al.* (2005) [25]. The hyperglycemia in impaction may be due to stress leading to adrenocorticosteroid release, which has glycogenolytic effect (Hussain and Uppal, 2012) [9]. The secretion of insulin in ruminants is induced by butyrate and propionate which in turn may lead to suppression of gluconeogenesis and increases in lipogenesis. After rumen impaction volatile fatty acids are not synthesized in sufficient quantity to meet the energy demand, so the animal has to

depend on oxidation of glucose rather than volatile fatty acid metabolism (Kaneko *et al.* 2008) [2]. Holtenius *et al.* (2000) [7] reported that lead to inhibition of the vagal cholinergic system that results in reduced motility of abomasum and decreases the acid secretion and thus led to the elevated pH of the abomasal fluid in abomasal impaction.

Enteritis is another disease in which hyperglycemia is encountered. Among the three cases two were of hemorrhagic enteritis. Hyperglycemia in hemorrhagic enteritis was also reported by (Dennison *et al.*, 2002) [5]. He reported hyperglycemia in 18 out of 19 cases of hemorrhagic diarrhea with serum glucose concentration ranging from 105 to 550 mg/dl. Enteritis due to clostridial infection is commonly associated with hyperglycemia. Hyperglycemia in enteritis is also related to the stress with resultant endogenous steroid and epinephrine release (Simpson *et al.*, 2018) [19]. Also enteritis is reported as one of clinical signs in diabetic cattle (Şahinduran *et al.*, 2016) [17].

Second highest prevalence is for Pneumonia. In humans also the hyperglycemia related to clinical diseases has highest incidence in respiratory diseases (Weiss *et al.*, 2010) [24].

Other respiratory system involvement is hydrothorax. The cause is same as for the intestinal diseases *i.e.*, stress induced elevation of cortisol. However, one reported case of diabetes in cattle with hydrothorax and enteritis.

In renal insufficiency, all the three cases reported hyperglycemia with glycosuria. Glucose is freely filtered and then reabsorbed in the proximal tubules, preserving it to be utilized as an energy source. If the blood glucose level is too high (hyperglycemia), it exceeds the renal threshold and the glucose is excreted in the urine. But in cases of renal pathology, there may be glycosuria without the presence of hyperglycemia as resorption efficiency is affected. But in present study there are no case reported for glycosuria without hyperglycemia. The reason may be that these cases are being affected from long time period and resulting stress lead to elevated level of glucose. In UTI, there may be glycosuria without hyperglycemia but in present study there was no glycosuria in UTI cases. This could be due to small number of cases included in study.

There were 5 cases in which corticosteroid were administered in earlier treatment. One of the cases was administered with dexamethasone 2 days prior to coming to the clinics; it had glucose value of 194.7 mg/dl. One case was administered with prednisolone and remaining three cases were administered with isoflupredone acetate. In prednisolone administration, there was no glycosuria and rise in glucose level (98.7 mg/dl) was below threshold. Ting *et al.* (2004)^[22] also found that the sustained infusion of cortisol in buffalo calves resulted in increased plasma glucose, insulin and GH concentrations. Glucocorticoids are steroid hormones that regulate multiple aspects of glucose homeostasis. Glucocorticoids promote gluconeogenesis in liver, whereas in skeletal muscle and white adipose tissue they decrease glucose uptake and utilization by antagonizing insulin response. Therefore, excess glucocorticoid exposure causes hyperglycemia and insulin resistance (Kuo *et al.*, 2015)^[11]. However, hyperglycemia that occurs within 24 hours of glucocorticoid administration appears to result from a repartitioning of glucose in the body rather than from gluconeogenesis (Constable *et al.*, 2017)^[25].

Conclusion

Hyperglycemia and diabetes are two important but yet less explored conditions in buffaloes. They are generally related to oxidative stress or stress induced cortisol release. Almost all common conditions encounter hyperglycemia as in the present investigation where hyperglycemia has been commonly encountered in pneumonia, diaphragmatic hernia and traumatic reticuloperitonitis cases in buffaloes. Thus it is important to measure blood glucose level in clinical case and to rule out whether hyperglycemia due to disease stresses or due to underlying diabetes.

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