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Diagnosis and Therapeutic Management of Diabetes Mellitus in Canine

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ABSTRACT

Diabetes mellitus (DM) is a common endocrine disorder affecting both canines and felines, characterized by persistent hyperglycemia and glucosuria due to either decreased production or decreased action of insulin or both. In this study, during the period of two years, a total of 2500 dogs were presented to the clinics and out of these 254 dogs were having primary complaint of polyuria and polydipsia. Among these a vast majority of the dogs were diagnosed with chronic kidney disease (58.2%) followed by hepatic disease (24.4%) and pyometra (09%) and only seven animals (2.7%) were diagnosed with DM based on persistent hyperglycemia (390.71mg/dL) and glucosuria (3+). Majority of these animals were females (n=5) and rest were males (n=2). The most commonly presented breeds were Dachshund (57.1%) followed by Labrador retriever (28.5%), pug and Shih-tzu (14.2% each) respectively. Most prevalent age group during this study was 4-5 years as all the females affected were falling in this age group. Rest of the two males were of 09 and 11 yrs, respectively. Clinical signs in these dogs included polyuria, polydipsia, weight loss in all the animals. Inappetence (71.4%), polyphagia (28.5%) and vomiting (28.5%) were seen uncommonly. Complications associated with DM in this study include cystitis (28.5%) and cataract (28.5%), respectively. Treatment was done based on American Animal Hospital Association (AAHA) guidelines with exogenous administration of insulin along with strict dietary management and implementation of exercise in routine schedules. Remission time in these dogs was 15 d and average dose of insulin was 0.63 IU/kg. The present study concluded the need of more elaborative studies as the present sample size was less and the importance of dietary management and exercise among pet owner.

Keywords: Cataract, Diabetes mellitus , Polyuria, Polydipsia, Polyphagia, Weight loss.

INTRODUCTION

Diabetes mellitus is defined as a complex endocrine disorder characterized by chronic hyperglycemia and glucosuria resulting either from decreased production or decreased action of insulin or both (Niessen *et al*, 2022). Hyperglycemia is defined as an increased blood glucose concentration of more than 125 mg/dL, but clinical signs are usually not detectable until the renal tubular resorption threshold for glucose is exceeded, *i.e.,* more than 180 mg/dL. DM is a common endocrinopathic disorder among dogs and is characterized by polyuria, polydipsia, polyphagia, and weight loss. Apart from these clinical signs, associated complications include cystitis, latrogenic hypoglycemia, diabetic neuropathy, diabetic nephropathy, and cataract formation (Nelson and Couto, 2019). The estimated prevalence of DM among the dog population ranges between 0·0005 and 1·5 per cent (Wilkinson, 1960).

Etiology among the dogs tends to be multifactorial, with beta cell loss, particularly due to immune-mediated mechanisms, vacuolar degeneration, and pancreatitis as the major ones (Haritha *et al,* 2024; Davison *et al,* 2003). Apart from these genetic predispositions, infection, insulin-antagonistic drugs, and obesity have also been identified as causal factors. The result among the majority of these is loss of beta cells. Genetic predisposition is proved by the fact that certain breeds of the dogs are at increased risk of developing DM as compared to the other breeds with Samoyeds, Miniature Schnauzers, Miniature Poodles, Pugs, and Toy Poodles being at greater risk of developing DM, while lower risk was associated with certain breeds like German Shepherd Dog, Golden Retriever, and American Pit Bull Terrier (Hess *et al*, 2000)

Not only breed predisposition, but also gender and the age group affected help in elucidating the cause of the disease. Intact female dogs and neutered males were at increased risk of developing DM as compared

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to the intact males (Marmor *et al*, 1982; Heeley *et al*, 2020). Dogs more than 8 yrs of age have increased odds of developing the disease (Heeley *et al*, 2020). Among the intact females, insulin resistance serves as a major cause of DM, particularly due to the effects of the diestrus phase. This, in turn, is proved by the fact that ovariohysterectomy removes the source of progesterone and improves the tissue responsiveness to insulin. The classification system is similar to the one used among the human population. Type 1 insulin-dependent DM is the most common among dogs. Type 2 Insulin-independent DM is not clinically recognized among the dogs.

Despite a multifactorial etiology, the clinical signs in the vast majority of the dogs with DM include polyuria, polydipsia, polyphagia, and weight loss. Increased fat mobilization leads to hepatic lipidosis and hepatomegaly. If the dog is not treated for the primary causes, a protracted course of the disease will lead to ketonemia, ketonuria, and in severe cases, Diabetic ketoacidosis. Treatment involves lifelong administration of Insulin as the vast majority of the dogs are suffering from type 1 DM. Apart from Insulin administration, reducing insulin resistance in obese animals and in intact females has an important role in the management of DM. Mean survival time after the onset of diagnosis in dogs is up to 2 years of age, but with adequate glycemic control and dietary management, a good quality of life can be sustained up to 5 years of age (Sinha *et al,* 2024; Fall *et al*, 2007). The present study was conducted to determine the prevalence of diabetes mellitus among dogs presented with polyuria and polydipsia and to evaluate the associated demographic factors, clinical signs, complications, and therapeutic response following insulin therapy and management as per AAHA guidelines.

MATERIALS AND METHODS

This study was conducted over a period of 2 yrs at the Veterinary Polyclinic, Faridkot, on dogs presented with the history of polyuria and polydipsia. A total of 2500 dogs were presented over a period of 2 yrs. Among these animals, 254 animals were presented with the history of polyuria and polydipsia. Anamnesis, physical examination, and routine workup, including CBC, Liver function test (LFT), Kidney function test (KFT), Blood glucose, routine urinalysis, along with urine sediment examination and radiography, were done to elucidate the cause of the disease. Complete physical examination, along with the signalment recording, was performed in all these animals to determine the exact cause of the disease. Routine blood workup, urinalysis, and radiography were done using the recommended methods from the local laboratories. The majority of these dogs were diagnosed with chronic kidney disease (n=148), followed by hepatic disease (n=62), pyometra (n=23), and DM (n=07). In the rest of the cases (n=14), etiology was not established. Apart from the dogs diagnosed with DM, the rest were treated using the appropriate guidelines provided. Dogs in which the etiology was not established were referred to the referral hospital to determine the cause of the disease.

Dogs diagnosed with DM were selected, and various parameters, including age, sex, breed, clinical signs such as polyuria, polydipsia, polyphagia, weight loss were noted. Apart from the associated clinical signs, complications such as cataract, urinary tract infection and iatrogenic hypoglycemia, if developed, were noted. Diagnosis of DM was confirmed based on persistent hyperglycemia and glucosuria; because the more reliable test, *i.e.,* serum fructosamine, was not available at the local laboratories. Blood glucose estimation was done by collecting venous blood from restrained animal and submitted to the local laboratory using appropriate methods. Urine in these animals was collected on free catch basis and in animals suspected for lower urinary tract disease urine collection was done by cystocentesis. These urine samples were then subjected to dipstick analysis and sediment examination. Treatment in the affected animals was done using the recommended guidelines (Behrend *et al*, 2022) and response to treatment, along with remission time, was recorded. Owners were trained for subcutaneous administration of Insulin and blood glucose estimation using the routinely available glucometer (Accu-check Instant). Remission was said to occur when the polyuria and polydipsia have improved, and the dog has started to gain weight. All the above findings were noted down in a Microsoft Excel worksheet, and the descriptive analysis was performed.

RESULTS AND DISCUSSION

A total of 2500 dogs were examined during a period of two years, and out of these animals, 254 were screened because of the primary complaint of polyuria and polydipsia. A vast majority of these cases were diagnosed to be of chronic kidney disease (58.2%) based on the laboratory findings, such as elevated BUN and Creatinine values, along with anemia, hyperphosphatemia, and urinalysis findings. These findings were later confirmed using the ultrason-

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ographic findings, which in the majority of the dogs revealed loss of cortico-medullary differentiation.

The second most common etiology for the presenting clinical signs was hepatic disease (24.4%), which was suspected based on the clinical signs and the findings of the liver function test and later confirmed using the USG findings from the referral hospitals. Pyometra (09%) is the other cause in dogs presented with polyuria and polydipsia. Pyometra in dogs was confirmed primarily based on the findings of CBC, such as leucocytosis and radiography. In a dog in which radiographic findings were not evident, USG was advised to confirm the diagnosis.

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Among the 2500 dogs examined, a total of 7 dogs were diagnosed with DM, with a prevalence rate of 0.28%. These findings were in accordance with the previously done studies of Wilkinson (1960) which stated prevalence in the range of 0·0005 and 1·5 per cent. Among the dogs presented, majority were females (71.4%), and the rest were males (28.6%). These findings were in agreement with the previously done studies of Heeley *et al*, (2020) according to which 48.2% of the animals presented were females. As far as the age is concerned, the majority of the dogs presented were 04 to 05 years of age (n=05), and the rest of the dogs (n=02) were 09 and 11 years respectively. All the dogs within the age group of 4-5 years of age were females, and the rest of the dogs, which were more than 09 years of age, were male. These findings were in contrast to the previous studies of Heeley *et al*, 2020 which showed that increased odds were associated with animals more than 8 years of age. The possible reason in these dogs might be due to the intact nature of females, in which the diestrus phase leads to insulin resistance (Nelson and Cuoto, 2019). Whereas in males, the findings were in association with the previous studies (Heeley *et al*, 2020).

The most commonly presented breeds during this study were the Dachshund (57.1%), followed by the Labrador retriever (28.5%), Pugand Shih-tzu (14.2% each) respectively. These findings were in contrast to studies of Hess *et al*, (2000) in which Samoyeds, Miniature Schnauzers, Miniature Poodles, Pugs, and Toy Poodles were at greater risk of developing DM. The possible reason may be due to the overpresentation of Dachshund at clinic. Clinical signs observed in these dogs were polyuria, polydipsia, polyphagia, and weight loss. Polyuria, polydipsia, and weight loss were present in all seven dogs presented, whereas polyphagia was seen in only two dogs (28.57%), and the rest had inappetence (71.42%). These findings were in accordance with the previously done studies of Plotnick and Greco (1995) which stated presence of polydipsia in 93% of dogs, polyuria in 77%, weight loss in 44% and polyphagia in only 19% of the dogs. The low prevalence of polyphagia in these animals may be due to concurrent ketoacidosis (Plotnick and Greco, 1995).

Cataract formation was seen in only two dogs (28.57%), and the possible reason for this might be due to the advanced nature of the disease. Whereas vomiting at the time of presentation was seen in two dogs (28.57%). The presence of Gastrointestinal signs, such as inappetence and vomiting, may be associated with concurrent pancreatitis and cholangio-hepatitis (Greco, 2001). Diagnosis in these animals was based on persistent hyperglycemia along with glucosuria. The more reliable test, i.e., serum fructosamine, cannot be evaluated due to the unavailability of this test in the local area. The average blood glucose concentration in these dogs was 390.71 mg/dL, whereas in the majority of the dogs, the urinalysis findings suggested a 3+ concentration of glucose in the urine. These findings of concurrent glucosuria and hyperglycemia have been used for a long time in the diagnosis of DM and are also the test of choice in field conditions, where the availability of newer and more reliable tests is sparse. The possible reason for glucosuria suggests the presence of hyperglycemia, which exceeds the renal tubular resorption threshold.

Urine sediment examination was also performed in addition to routine urinalysis in all the dogs to know whether concurrent lower UTI disease is present or not. Only two dogs (28.57%) were having lower urinary tract disease. These animals in addition to lower urinary tract disease signs such as stranguria, hematuria and pollakiuria were also having elevated pus cell count/hpf in the sediment. Most of these dogs, particularly during the early phase of treatment, also developed the other complication of DM i.e., iatrogenic hypoglycemia which was already explained to the owner and was managed at home by the owner using the application of sugar solution/honey to the gums. The possible reason could be the higher dosage of Insulin, particularly during the initial phases of treatment when the dosage of insulin is not completely set (Idowu and Heading, 2018). Dogs, upon diagnosis, were treated based on the guidelines provided by AAHA. Treatment involves exogenous administration of insulin along with dietary modification and incorporation of exercise in the routine schedule of dogs to overcome obesity and any type of insulin resistance if present (Behrend *et al,* 2022). All the dogs

were initially treated using intermediate-acting Insulin preparation (NPH) @ 0.5 IU/kg body weight bid.

In most of the dogs (85.7%), remission was seen by using this product, whereas in one dog, Lente insulin was used due to the non-remission using the NPH insulin. Remission time in dogs after using Insulin was 15 days, and the average dosage was 0.63 IU/kg. This remission was achieved after constant glucose monitoring at home using the commercially available glucometers (Accu-check instant). Apart from exogenous insulin administration, owners were advised for dietary modification, which was entirely based on AAHA guidelines. It involves either feeding the commercially available feeds for diabetic dogs, and those who can't handle the expenses of the commercially available diet were advised to restrict caloric intake and increase expenditure through exercise. Increasing the fibre content of the feed serves as a central point in managing DM (Behrend *et al*, 2022). All of these animals are followed up on since the onset of diagnosis. Despite the proper treatment, two of these animals succumbed to the disease with a case fatality rate of 28.57%. Both of these dogs died within 1.5 years of diagnosis of the disease. These findings were in agreement with the previous studies done of Fall *et al* (2007) which stated median survival time of two years after the onset of diagnosis. This study was done to check the prevalence of DM over a period of two years, but the sample size over a period of two years was quite small, necessitating the need for further studies to be conducted to know the prevalence and the causal factors associated with the onset of the disease.

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CONCLUSION

Diabetes mellitus in dogs is a common endocrine disorder characterised by persistent hyperglycemia and glucosuria, with decreased production or decreased response to insulin or both being the major causes of the disease. Treatment entirely focuses on exogenous administration of insulin along with dietary management and introduction of exercise. The present study necessitates the pet owner education about the etiopathogenesis of the disease, along with the management strategies to curb the disease.

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