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Systemic hypertension in diabetic dogs

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Abstract

The present study was conducted on the dogs presented to small animal OPD, Teaching Veterinary Clinical Complex, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, Punjab with signs of endocrinopathies. Fifty five Dogs with naturally occurring diabetes mellitus (DM) diagnosed were used in this study. DM was diagnosed by persistent marked hyperglycemia (plasma glucose >250 mg/dl) and glucosuria in dogs with clinical signs consistent with the disease. The study revealed that mean systolic BP was significantly higher in diabetic dogs (145.24 ± 1.82 mmHg) when compared to normal dogs (123.6 ± 1.37 mmHg) and the prevalence of systolic hypertension (systolic BP >150 mmHg) was 30.91 per cent (17/55 cases). The highest recorded systolic BP was 177 mmHg in 1 dog. The mean diastolic pressure was significantly higher in diabetic dogs (97.29 ± 1.2 mmHg) as compared to normal dogs (84.00 ± 1.11 mmHg). The prevalence of diastolic hypertension (diastolic BP >95 mmHg) was recorded in 61.81 per cent (34/ 55) diabetic dogs. Diastolic BP exceeded 100 mmHg in 18 dogs, with the highest measurement being 121 mmHg. Both systolic and diastolic hypertensions were present in 13 dogs (23.64%). In the present study the severity of systolic hypertension, when considered as risk of target organ damage was mild in all dogs as blood pressure was less than 160 mmHg, but 7 dogs had moderate risk (B.P.>160 mmHg) and one dog had severe risk of organ damage (BP>175 mmHg).

Keywords: Blood pressure, diabetes mellitus, dogs, organ damage

Introduction

m Endocrinopathies stem from imbalances in hormone levels and are manifested by derangement of functions in target organs such as bilateral symmetrical alopecia/thin skin in Cushing's or hypothyroidism and polyuria/polydipsia in diabetes mellitus. Common endocrinopathies and their prevalence in different countries are 0.32- 1.33 percent for diabetes mellitus (Hoenig, 2002 and Davison *et al.*, 2005) ^[13, 5] and 0.2-0.8 per cent for hypothyroidism (Dixon *et al.*, 1999) ^[6]. Diabetes mellitus (DM) is a common disorder of endocrine pancreas, affecting mostly females and middle aged (> 5 years) to geriatric dogs. Diabetes mellitus has been traditionally classified into type I (T1DM) and type II diabetes (T2DM), with T1DM resulting from immune-mediated destruction of pancreatic B-cells, and T2DM resulting from insulin resistance in target tissues. Diabetes mellitus (DM) can result in vascular complications such as nephropathy, systemic hypertension, and retinopathy. These comorbidities are well documented in dogs with experimentally induced DM and were found to develop after several months to 2.5 years of disease, depending on the model. While systemic arterial hypertension, nephropathy, and retinopathy are recognized in dogs with spontaneous DM (Herring *et al.*, 2014) ^[12]. Systemic hypertension occurs in insulin dependent diabetes mellitus as a result of arteriosclerosis and increased peripheral vascular resistance (Littman, 2000; Cruickshank *et al.*, 2002) ^[18, 4]. Systemic hypertension was found in about 46 percent of diabetic dogs (Struble *et al.*, 1998) ^[24]. It plays an important role in the development and progression of diabetic nephropathy in human beings (Patel, 2007) ^[21].

Material and Method

The present study was conducted on the dogs presented to small animal OPD, Teaching Veterinary Clinical Complex, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, Punjab with signs of endocrinopathies from June 2018 to Feb 2020. Fifty five Dogs with naturally occurring diabetes mellitus (DM) diagnosed less than 1 year before evaluation were used in this study. DM was diagnosed by persistent marked hyperglycemia (plasma glucose >250 mg/dl) and glucosuria in dogs with clinical signs consistent with the disease. Blood pressure measurement: The blood pressure was measured using VET-HDO-MONITOR-NIBPSYSTEM which is a compact, portable, battery or mains operated monitor. It works on high definition oscillometric principle, where an inflated cuff, placed around the

patient's limb, inflates and deflates in one cycle to measure the systolic, diastolic and mean arterial blood pressure values (Martel *et al.*, 2013)^[19].

The mean of the three readings of systolic, diastolic and mean arterial blood pressure was measured after putting the animal in lateral/ sternal recumbency. For small dogs D1 cuff and large dogs D2 cuff was used to measure blood pressure at just below elbow joint and tail cuff at the base of tail (coccygeal artery). The machine was started and then automatically the cuff inflated to a suprasystemic pressure of 225 mm/Hg and then deflated slowly to a pressure of 25 mm/Hg. The monitor automatically determined the mean arterial blood pressure (MAP), systolic blood pressure (SAP), diastolic blood pressure (DAP) and pulse. Systolic hypertension was defined as systolic blood pressure (BP) >150 mmHg and diastolic hypertension was defined as diastolic BP >95 mmHg (Brown *et al.*, 2007)^[2].

Statistical analysis

Systolic and diastolic indices were compared between diabetic and control groups using independent samples t-test. Data was subjected to statistical methods using SPSS software 16th version. A two tailed P-value less than 0.05 was considered as statistically significant.

Results and Discussion

Diabetic vascular complication that is hypertension was documented in this study and blood pressure was measured in 55 diabetic dogs. The mean values of systolic and diastolic blood pressure in diabetic and normal dogs are described in Table 1. Mean systolic BP was significantly higher in diabetic dogs (145.24 ±1.82 mmHg) when compared to normal dogs (123.6±1.37 mmHg) and the prevalence of systolic hypertension (systolic BP >150 mmHg) was 30.91 per cent (17/55 cases). Systolic BP exceeded 160 mmHg in 7 dogs. The highest recorded systolic BP was 177 mmHg in 1 dog. The mean diastolic pressure was significantly higher in diabetic dogs (97.29±1.2 mmHg) as compared to normal dogs (84.00±1.11 mmHg). The prevalence of diastolic hypertension (diastolic BP >95 mmHg) was recorded in 61.81 per cent (34/55) diabetic dogs. Diastolic BP exceeded 100 mmHg in 18 dogs, with the highest measurement being 121 mmHg. Both systolic and diastolic hypertensions were present in 13 dogs (23.64%). In the present study proteinuria was observed in 38 (69.09%) diabetic dogs. Diabetes mellitus is known to cause secondary hypertension in dogs (Littmann, 2005; Brown *et al.*, 2007)^[18, 2]. Similarly Priyanka *et al.* (2018)^[22] recorded 58.82 per cent prevalence of hypertension was in diabetic dogs. This finding is supported by earlier studies. Struble *et al.*, (1998)^[24] found hypertension in 45% of diabetic dogs. The prevalence of systolic and diastolic hypertension in the present study was similar to studies of Mazzi *et al.* (2008)^[20] and Herring *et al.* (2014)^[12] who reported systemic hypertension in dogs with spontaneous DM. Herring *et al.* (2014)^[12] reported that the highest recorded prevalence of systolic and diastolic hypertension was 55 and 64 per cent, respectively. Disturbed lipid metabolism leading to reduced vascular compliance, generalized glomerular hyperfiltration, increased peripheral vascular resistance and vasculopathy, etc will contribute to the development of hypertension in diabetic dogs (Dukes, 1992; Kraft and Egner, 2003)^[8, 15]. In the present study the severity of systolic hypertension, when considered as risk of target organ damage was mild in all dogs as blood pressure was less than 160 mmHg, but 7 dogs had

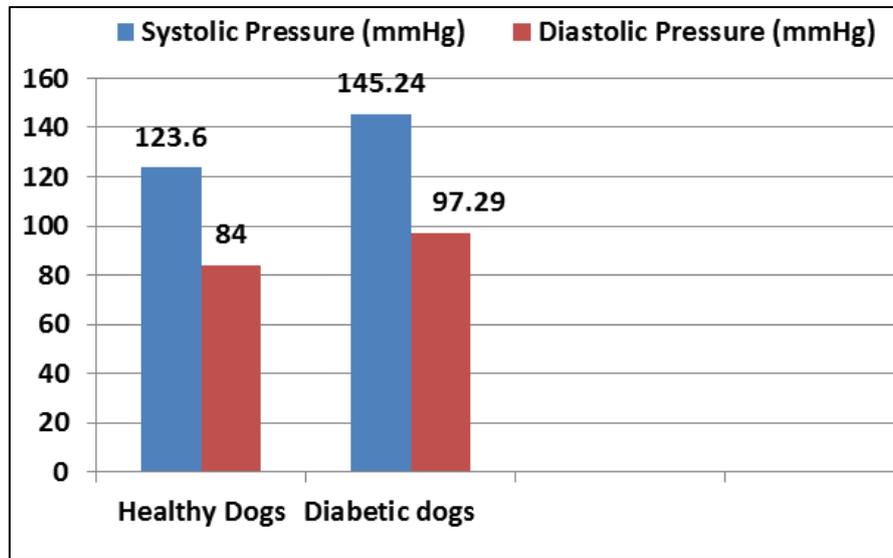
moderate risk (B.P>160 mmHg) and one dog had severe risk of organ damage (BP>175 mmHg) (Brown *et al.*, 2007)^[2]. Similar to a previous report, diastolic hypertension occurred more frequently than systolic hypertension (Struble *et al.* 1998)^[24]. Additionally, the diastolic pressure elevation was higher in magnitude than the systolic pressure, relative to proposed risk to target organs (Brown *et al.*, 2007)^[2]. The present study was in accordance to Struble *et al.* (1998)^[24] who reported that the risk of hypertension increased with more prolonged diabetes mellitus (DM). Priyanka *et al.* (2018)^[22] reported systemic hypertension and proteinuria in 10 and 3 out of 17 diabetic dogs, respectively. On the contrary, Herring *et al.* (2014)^[12] concluded that any effect of DM on BP may occur early in the course of the disease. Another study reported that dogs with unilateral nephrectomy and induced DM had a peak increase in mean arterial pressure after 4 months, that then decreased through the remainder of the 1-year study (Brown *et al.*, 1993)^[3]. In humans, hypertension occurred in approximately 30 per cent of those with type 1 DM and 50–80 per cent of those with type 2 DM (Landsberg and Molitch, 2004)^[16]. Hypertension was commonly present at the time of diagnosis of diabetes in humans with type 2 disease, while in type 1 diabetes, it occurred later in the course of disease and was most commonly believed to be a consequence of nephropathy (Sowers *et al.*, 2001)^[22]. Hyperglycemia and increases in total body exchangeable sodium may lead to extracellular fluid accumulation and expansion of the plasma volume (Donald and Simonson, 1988)^[7]. Loss of renal auto regulation in hypertensive diabetic patients leads to glomerular hypertension and diabetic nephropathy (Hayashi *et al.*, 1992)^[11]. Elevated BP is associated with increasing risk of diabetic nephropathy in humans and dogs with experimentally induced DM (Bakris *et al.*, 2003)^[1]. While angiotensin-converting enzyme inhibitors attenuate progression of diabetic nephropathy in alloxan-induced diabetic dogs (Herring *et al.*, 2014)^[12]. As renal insufficiency develops, blood pressure rises and may exacerbate the progression to end-stage renal failure (Donald and Simonson, 1988)^[7]. It has traditionally been stated that the hypertension of diabetes is volume dependent. Hyperglycemia increases the osmolality of the extracellular fluid. As water shifts from the intracellular to extracellular space to maintain osmotic equilibrium, the extracellular space is expanded at the expense of intracellular dehydration. Unless hyperglycemia is sufficiently severe to produce an osmotic diuresis, a state of volume overload will exist. Indeed, an increased plasma volume has been demonstrated in both diabetic animals (Donald and Simonson, 1988)^[7] and diabetic humans. Second, total-body exchangeable sodium is frequently increased in patients with diabetes (Koenhemi *et al.*, 2016)^[14], and an exaggerated pressor response to a high-sodium diet has been observed in some diabetic individuals.

Presence of proteinuria in 69.09 per cent of diabetic dogs in present study was supported by Priyanka *et al.* (2018)^[22] who reported mild proteinuria in 17.65 per cent diabetic dogs. Herring *et al.* (2014)^[12] also observed proteinuria in 55 per cent of diabetic dogs. Proteinuria has been directly related to the extent of increase in BP and to the rate of decrease in GFR in an experimental study in dogs Finco. (2004)^[9]. Chronic hyperglycemia causes renal damage by glycosylating the glomerular proteins and finally leads to progressive renal failure by damaging various cell types of the kidney (Lin *et al.*, 2006; Fioretto and Mauer, 2007)^[17, 10].

Table 1: Systolic BP and Diastolic BP in diabetic dogs at initial evaluation

Parameter	Healthy Dogs (Mean±S.E.) (N=10)	Diabetic dogs (Mean±S.E.) (N=55)	P-Value
Systolic Pressure (mmHg)	123.6±1.37 (115-131)	145.24±1.82** (118-177)	0.00
Diastolic Pressure (mmHg)	84.00±1.11 (78-89)	97.29±1.2** (73-121)	0.00

** superscripts depicts significant difference at 1% ($P \leq 0.01$)

**Fig 1:** Systolic BP and Diastolic BP in diabetic dogs at initial evaluation

Conclusion

In the present study it was concluded that both systolic and diastolic hypertension were prevalent in diabetic dogs. It can result into diabetic nephropathy, ultimately leading to renal failure. The spectrum of vascular complications associated with DM in the dog is similar to that recognized in humans and includes systemic hypertension.

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