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Short Communication

Radiographic evaluation grid - an assessment tool for cardiac affections diagnosis in dogs

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Dogs have been domesticated by man since a long time and are considered as best companion of man since civilization. Cardiac diseases are commonly encountered in general veterinary practice and it is estimated that approximately 10-15 % of dogs are affected with heart diseases (Mac Pete, 2018). In dogs, cardiac diseases are serious and life threatening in nature. So their early diagnosis is essential. Auscultation, radiography, electrocardiography, echocardiography and biochemical tests are most useful diagnostic procedures employed in diagnosis of cardiac diseases in dogs **(**Hoque *et al*., 2019).

Thoracic radiography is the most commonly applied method for the diagnosis of congestive heart failure (CHF) and considered as the clinical gold standard (Balbarini *et al*., 1991). It is focused on the evaluation of the size and shape of the cardiac silhouette (Baisan *et al*., 2017). The vertebral heart score (VHS) is a method for objectively evaluating the dimensions of the cardiac silhouette in thoracic radiograms. It has been demonstrated to be useful for evaluating cardiac enlargement associated with eccentric hypertrophy due to volume overload in canines (Guglielmini *et al*., 2014). Many questions remain in the interpretation of canine thoracic radiographs and, to our knowledge no previous study has reported the correlation between radiographic evaluation and echocardiographic findings in dogs. The objectives of this study were to develop an evaluation grid to interpret canine thoracic radiographs and to determine the sensitivity and specificity of thoracic radiographs for detection of cardiac affections based on echocardiography as the gold standard.

Medical records of all 2582 dogs that were presented to Veterinary Clinical Complex, LUVAS, Hisar between August 2019 and March 2020 was taken. Based on signalment and clinical screening, dogs suspected for cardiac affection were included in the study.

a) Radiographic examination

Thoracic radiography was performed in all dogs with an X-ray unit (Siemens X- Ray machine) and images processed through Computed radiography system (Konica Minolta PVT, LTD). All animals were positioned in lateral and ventrodorsal or dorsoventral position without giving any kind of sedation. For canine chests, kV range of 50 to 80 and mAs range of up to 40 mAs was used (depending upon the size of dog). The heart size in the lateral view was evaluated by using vertebral heart scale (VHS) as described by Buchanan and Bucheler (1995).

Radiographic evaluation grid was developed as suggested by Masseau *et al.* (2008) with some modifications to identify cardiac abnormality. Radiographic evaluation grid includes findings such as VHS, globoid cardiac silhouette, sternal contact etc (Table 1). All radiographs were evaluated independently by 2 blind folded radiologists who were not aware of the history and clinical findings. All the findings were recorded on evaluation grid by radiologists and after discussion and on general agreement, final diagnosis was awarded.

b) Echocardiographic examination

Radiographically suspected dogs were further analysed through B and M- mode echocardiography. Data regarding diagnosed diseases and presence of effusion was recorded.

c) Analysis

Sensitivity and specificity of radiographs to detect cardiac diseases were estimated. Forty one dogs met the inclusion criteria for the study. Dogs were suspected based on signalment viz. dyspnoea, exercise intolerance, abdominal distension and lethargy and clinical examination i.e. prolonged capillary refill time, weak femoral pulse, ascites and systolic murmur. Lateral and ventro- dorsal thoracic radiographs had been taken to exclude thoracic lesions. A total of 11 cases showing respiratory abnormalities were ruled out as depicted in Table 2. Twenty seven dogs had cardiac abnormality based on the thoracic radiographs while three dogs showed

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Table 1 Radiographic evaluation grid

Case No.	VHS		Tracheal elevation	Globoid Cardiac silhouette	Sternal contact	Cardiogenic Pulmonary oedema	Pneumonic changes	Right ventricular enlargement	Ascites	Left ventricular enlargement	Other findings	Comments
	Norm	Inc										
	×	✓	✓									

no radiographic disturbance. Prevalence of various radiographic findings were depicted in Table 2.

Radiographically ruled thirty dogs were further screened through echocardiography. And out of thirty, twenty dogs found confirmed cardiac affected and further categorised into five affections i.e. Dilated cardiomyopathy, pericardial effusion, hypertrophic cardiomyopathy, right sided congestive heart failure and systolic dysfunction based on their characteristic echocardiographic findings. Radiographic findings in different cardiac affection are depicted in Table 3 and Figure 2.

On lateral radiograph, VHS was measured and significant increase in mean values of VHS was found in cardiac diseases affected dogs as compared to healthy control group. Cardiac diseases associated with increase in chamber dilatation were the main reported cause of high VHS i.e. cardiomegaly (Lord *et al.,* 2010). The mean values of vertebral heart score in dogs suffering from cardiac affections are presented in Figure 1. So, Vertebral heart score (VHS) was found to be easiest tool for diagnosis of cardiac diseases but VHS had unspecified sensitivity as milder cases may be missed especially in the setting of combined heart and lung disease (in many small breed dogs), and can suffer from considerable observer variation as stated by Schober *et al.* (2010) and Ferasin *et al.* (2013).

Most characteristic findings observed are globoid cardiac silhouette, increased sternal contact, cardiomegaly, tracheal elevation, left atrial, left ventricular and right ventricular enlargement followed by pulmonary oedema, ascites etc. Cardiogenic pulmonary edema seen in the present study may be because of increased pulmonary venous hydrostatic pressure resulting from an increased left atrial pressure as a result of more interstitial fluid produced than that can be accommodated by the lymphatic vessels (Saini, 2014).

The distension of pericardial sac with fluid caused cardiac silhouette to be enlarged and globoid (Kang *et al.,* 2019). Left atrial and left ventricular enlargement in HCM seems to be associated with concentric hypertrophy. Ware (2009) suggested that rounding of anterior border of cardiac silhouette with increased sternal contact suggestive of right sided enlargement. Increased sternal contact in present study was because of right ventricular enlargement. So certain radiographic abnormalities gave indication of certain cardiac affections i.e. left atrial enlargement and left ventricular enlargement in myocardial diseases i.e. DCM and HCM, globoid cardiac silhouette specific for PE and increased sternal contact

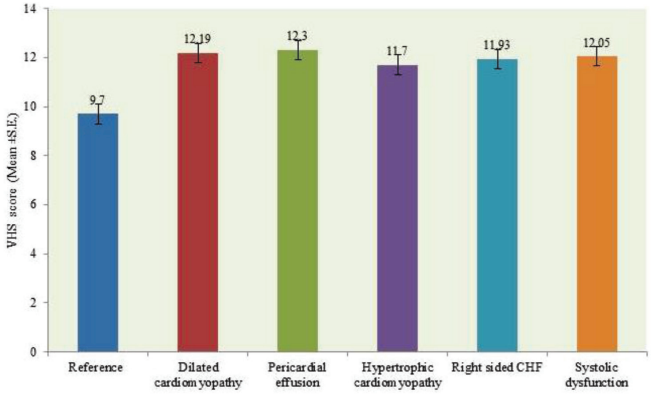

Fig. 1. Graphical representation of VHS mean value in dogs affected with cardiac affections

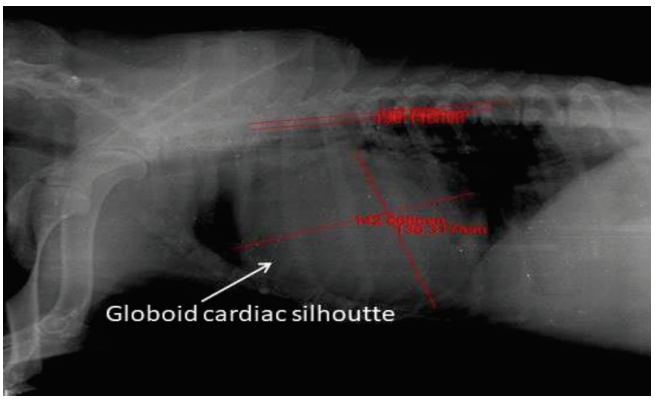

Fig. 2. Lateral Radiographic view in dog affected with pericardial effusion

Table 2. Radiographic findings in cardiac affections suspected dogs

Radiographic findings	Total no. of dogs screened (n=41)	Number of cardiac diseases affected dogs (n=20)
Cardiomegaly	19	17 (89.47%)
Tracheal elevation	13	10 (76.92%)
Pulmonary oedema	7	4 (57.14%)
Globoid cardiac silhouette	4	4 (100%)
Increased sternal contact	9	9 (100%)
Pneumonia	**11**	**0 (Ruled out cases)**
Left atrial enlargement	6	6 (100%)
Left ventricular enlargement	9	8 (88.89%)
Right ventricular enlargement	3	3 (100%)
No change	3	2 (66.67%)
Ascites	18	14 (77.78%)

Table 3. Radiographic findings in dogs suffering from different cardiac affections

Radiographic findings	DISEASES											
	Dilated cardiomyopathy (n=8)		Pericardial effusion (n=4)		Hypertrophic cardiomyopathy (n=3)		Right sided CHF (n=3)		Systolic dysfunction (n=2)		Total no. of cardiac cases (n=20)	
	No. of cases	%	No. of cases	%	No. of cases	%	No. of cases	%	No. of cases	%	No. of cases	%
Enlargement of left atrium	5	62.5	-	-	1	33.33	-	-	-	-	6	30
Elevation of trachea	5	62.5	3	75	1	33.33	1	33.33	-	-	10	50
Pulmonary congestion and oedema	3	37.5	-	-	1	33.33	-	-	-	-	4	20
Cardiomegaly	7	87.5	4	100	2	66.67	2	66.67	2	100	17	85
Globoid cardiac silhouette	-	-	3	75	-	-	1	33.33	-		4	20
LV enlargement	6	75	-	-	2	66.67	-	-	-	-	8	40
Increased sternal contact	3	37.5	3	75	1	33.33	3	100	-	-	10	50
RV enlargement	-	-			-	-	3	100			3	15
Ascites	6	75	4	100	2	66.67	2	66.67	-	-	14	70
No change	1	12.5	-	-	1	33.33	-	-	-	-	2	10

Table 4. Sensitivity and specificity of radiographs for the detection of cardiac affection in comparison with echocardiographic findings in 41 dogs

Cardiac affection	+/+	-/-	-/+	+/-	Total	Sensitivity (%)	Specificity (%)
	18	12	2	9	41	90	57.14

+/+ = true-positive; -/- = true-negative; -/+ = false-negative; +/- = false-positive

or right ventricular enlargement for R-CHF.

The sensitivity and specificity of radiographs for the detection of cardiac diseases based on echocardiographic examination are shown in Table 4. Radiographs are useful in detecting cardiac affections in dogs with a sensitivity of 90 per cent. Thus the probability of detecting cardiac diseases through radiographs in affected dogs is excellent

Conclusion

From the present study it can be inferred that thoracic radiography is useful tool for cardiac diseases diagnosis and present study provide an evaluation grid for systematic reading of thoracic radiograph as an aid in cardiac affection diagnosis.

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