

# ACCURACY OF THE MODIFIED VERTEBRAL HEART SCORE AND THE CARDIO-VERTEBRAL RATIO FOR RADIOGRAPHIC EVALUATION OF CARDIOMEGLY IN FERRETS



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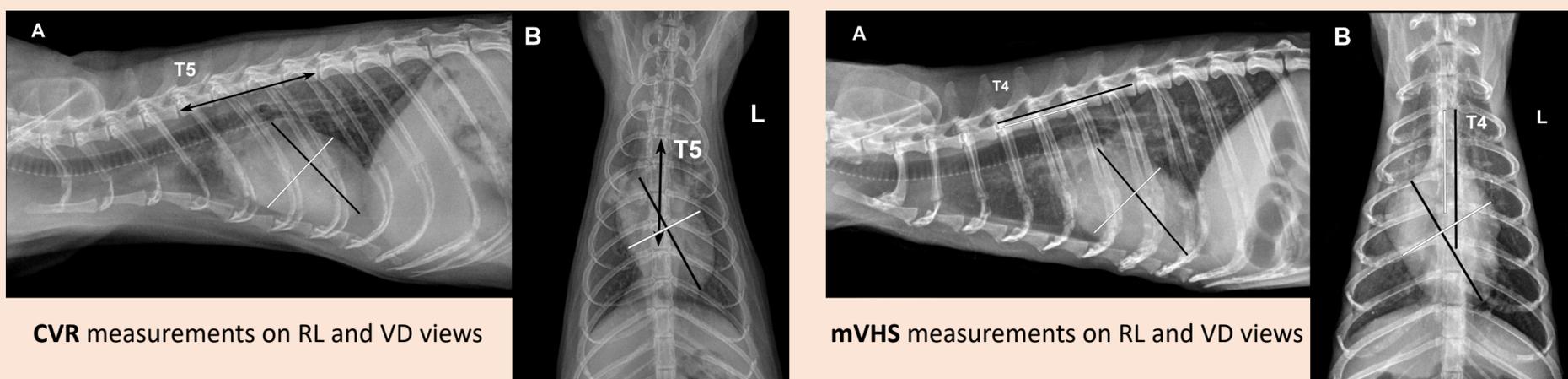
**Introduction:** Thoracic radiography is commonly used to assess the size of the heart and diagnose cardiac disease in pet ferrets. Several standardized radiographic heart size indicators have been introduced in this species and values in healthy ferrets have been reported<sup>1,2,3</sup>. To date, none of these indicators has been tested in ferrets with cardiac disease.

**Aim of the study:** To assess the accuracy of the **modified vertebral heart score (mVHS)** and the **cardio-vertebral ratio (CVR)** in the radiographic detection of cardiomegaly in ferrets.

**Materials and methods:** Thoracic radiographs of **24 ferrets with confirmed heart diseases (group 3)**, **22 ferrets with non-cardiac diseases and normal-sized hearts on echocardiogram (group 2)**, and **24 healthy ferrets (group 1)** were mixed and examined by three independent and blinded veterinary radiologists (Dip ECVDI) who measured mVHS and CVR in right lateral (RL) and ventrodorsal (VD) radiographs.

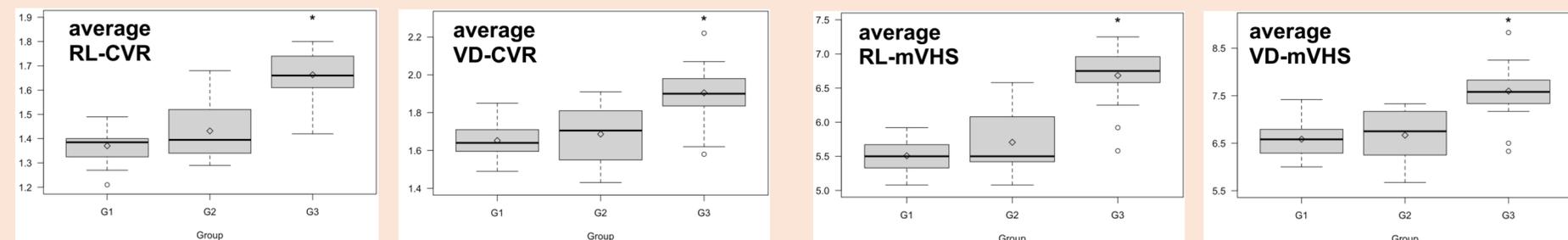
**CVR:** Linear measurements (in centimeters) of vertebral segment T5-T8 length, cardiac long axis (LoAx) and short axis (ShAx) obtained in RL and in VD projections are expressed to the nearest 0.1 cm. Unitless CVR is defined as the sum (LoAx + ShAx) divided by the T5-T8 measurement in the same projection : **RL-CVR** and **VD-CVR**.

**mVHS:** Cardiac LoAx and ShAx are expressed in units of vertebral length by repositioning LoAx and ShAx lengths over the thoracic spine beginning with the cranial endplate of T4 on the same projection and are estimated to the nearest 0.25 vertebra instead of 0.1 vertebra as recommended by Buchanan. The modified vertebral heart score is obtained by the sum of LoAx and ShAx in each view : **RL-mVHS** and **VD-mVHS**.

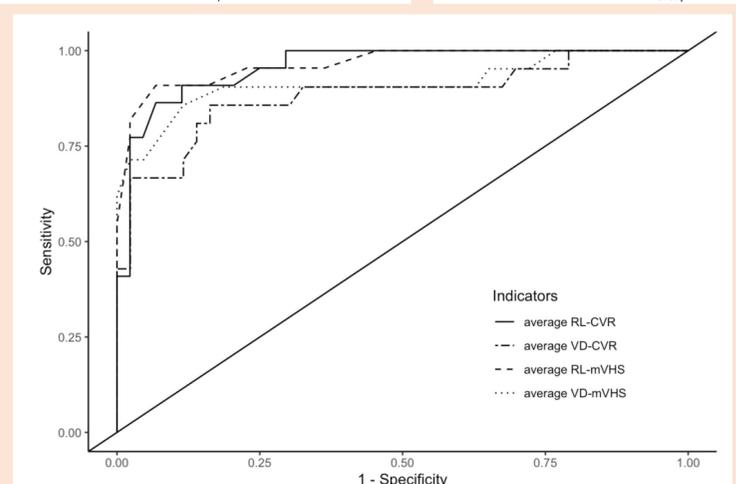


**Results:** Interobserver agreement of heart size indicators measurement assessed in 70 ferrets was excellent among the 3 readers for the 4 indicators. There was no significant influence of sex, body weight and age on the 4 indicators for each reader and in each group. In all average indicators, there was no significant difference between group 1 and group 2. For all readers, **ferrets with cardiac diseases (group 3) had significantly higher mVHS and CVR than ferrets with normal-sized hearts (groups 1 and 2)**. **Optimal cut-points** were **6.25 vertebrae** and **7.25 vertebrae** for **RL-mVHS** and **VD-mVHS**, and **1.58** and **1.80** for **RL-CVR** and **VD-CVR**, respectively. Using these cut-points, the accuracy was good for indicators measured in RL radiographs (92.9% for RL-mVHS; 91.4% for RL-CVR) and moderate for indicators measured in VD radiographs (88.6% for VD-mVHS; 85.7% for VD-CVR).

Average indicator	G1+G2 control group (n = 46)				Group 3 (n = 24)				P-value G3 vs (G1+G2)
	Median	Mean	IQR	Range	Median	Mean	IQR	Range	
RL-CVR <sup>a</sup>	1.39	1.40	1.34-1.46	1.21-1.68	1.66	1.66	1.61-1.74	1.42-1.80	<0.001*
VD-CVR <sup>a</sup>	1.66	1.67	1.59-1.77	1.43-1.91	1.90	1.91	1.84-1.98	1.58-2.22	<0.001*
RL-mVHS <sup>b</sup>	5.50	5.60	5.42-5.81	5.08-6.58	6.75	6.68	6.58-6.94	5.58-7.25	<0.001*
VD-mVHS <sup>b</sup>	6.67	6.63	6.25-7.00	5.67-7.42	7.58	7.60	7.34-7.83	6.33-8.83	<0.001*



	average RL-CVR <sup>a</sup>	average VD-CVR <sup>a</sup>	average RL-mVHS <sup>b</sup>	average VD-mVHS <sup>b</sup>
<b>Optimal cut-point</b>	<b>1.58</b>	<b>1.80</b>	<b>6.25</b>	<b>7.25</b>
<b>Normal heart group</b>				
<b>Median</b>	1.39	1.66	5.50	6.67
(IQR)	(1.34-1.46)	(1.59-1.77)	(5.42-5.81)	(6.25-7.00)
<b>Accuracy (%)</b>	91.4	85.7	92.9	88.6
95%CI	(87.7-98.0)	(75.9-93.9)	(87.7-98.9)	(81.5-96.0)
<b>Sensitivity (%)</b>	87.5	87	91.7	87
95%CI	(79.8-95.2)	(79.1-94.9)	(85.2-98.2)	(79.1-94.9%)
<b>Specificity (%)</b>	93.5	84.4	93.5	88.9
95%CI	(87.7-99.3)	(75.9-92.9)	(87.7-99.3)	(81.5-96.3)
<b>PPV (%)</b>	87.4	74.2	87.9	80.1
95%CI	(79.6-95.2)	(64.0-84.4)	(80.3-95.5)	(70.7-89.5)
<b>NPV (%)</b>	93.6	92.6	95.5	93
95%CI	(87.9-99.3)	(86.5-98.7)	(91.0-100.0)	(87.0-99.0)
<b>FP, ratio (%)</b>	3/70 (4.3%)	7/70 (10%)	3/70 (4.3%)	5/70 (7.1%)
<b>FN, ratio (%)</b>	3/70 (4.3%)	3/70 (4.3%)	2/70 (2.9%)	3/70 (4.3%)



**Conclusion:** Findings supported the use of mVHS and CVR for evaluating the size of the heart in diseased ferrets, with caution in values interpretation when pericardial fat prevents precise delineation of the cardiac silhouette contour especially on VD radiographs.

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