



OSCILLOMETRIC AND DOPPLER ULTRASONOGRAFIC ARTERIAL BLOOD PRESSURE MEASUREMENT IN CONSCIOUS HYPERTENSIVE CATS

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Abstract: Systemic hypertension, defined as a persistent increase in systemic blood pressure, is a disorder increasingly diagnosed in cats in recent times, with important consequences on internal organs. The damage that results from the presence of sustained high blood pressure is commonly referred to as end organ damage or TOD and the presence of TOD generally is a strong indication for antihypertensive treatment. Systemic blood pressure measurement is performed by two methods, directly and indirectly. In medical practice, the indirect method is most often used, mainly because of its non-invasive nature. This study aims to assess blood pressure measurements obtained using two indirect methods, oscillometric and Doppler ultrasound, in conscious cats. Thirty-six hypertensive cats of different breeds, age and sex were taken into the study. Systolic blood pressure was measured using the CARDELL Veterinary Monitor-9401BP and Vet-Dop2 devices, following the general rules of blood pressure measurement. Significantly different blood pressure values ($P=0.000 < P=0.05$) were obtained between the two methods, which argues for caution in their alternative use in monitoring the condition of hypertensive cats.

Keywords: arterial blood pressure, oscillometry, Doppler ultrasound, hypertensive cats

• Introduction

Systemic hypertension is characterized by a consistent rise in systemic arterial pressure, and its identification in cats has become more frequent recently. Systemic hypertension frequently leads to clinical complications such as ocular damage, encephalopathy, renal issues, and cardiovascular problems, collectively known as target organ damage (TOD). The exact prevalence of hypertension in dogs and cats remains unknown, due to the absence of standardized measurement methods, differing inclusion criteria, and varying thresholds for diagnosing hypertension in veterinary medicine, which complicate the interpretation of prevalence data. The recognized gold standard for monitoring arterial blood pressure is the invasive technique but most clinicians use noninvasive blood pressure (NIBP) methods, such as Doppler ultrasonography or oscillometric devices. In veterinary medicine, the standards for validating noninvasive blood pressure (NIBP) devices were established by the American College of Veterinary Internal Medicine (ACVIM) Consensus Statement. This statement was revised in 2018, recommending that all NIBP measuring devices should undergo validation. However, as of now, no indirect device has met the validation criteria for use in conscious dogs or cats. Consequently, blood pressure measurements in veterinary patients continue to be taken using the currently available indirect devices until proper validation studies are performed. This study aims to evaluate blood pressure measurements obtained with two indirect methods, oscillometric and Doppler ultrasound, in conscious cats, and to assess the reliability of these methods for monitoring hypertensive cats.

• Material and method

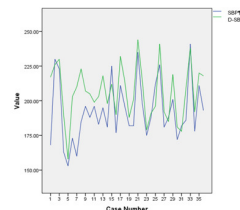
The study was conducted over a period of 2 years at a veterinary clinic in Timișoara, on 36 conscious cats diagnosed with systemic arterial hypertension (SBP). Of these, 23 were diagnosed with idiopathic hypertension (primary hypertension), and 13 with chronic renal failure (secondary hypertension). The cats belonged to various breeds and the cats' ages ranged from 4 to 19 years, with 17 females and 19 males. The SBP was determined noninvasively using both the CARDELL Veterinary Monitor-9401BP (Midmark) and a Vet-Dop2 device (Vmed Technology).

For each cat, the order of the Doppler and oscillometric examination was decided randomly. There were excluded the cats that were on medication known to affect blood pressure, and cats that had been sedated or anaesthetised within the previous 12 h. The standardized international protocol was implemented to obtain reliable results in the measurement of BP. A cuff with a width of approximately 40% of the limb or tail base circumference was selected. The chosen measurement site was at the level of the front limb in the radial artery region. The animal's position was in lateral recumbence, with the cuff at the same height as the heart, and the measurement began once the animal got used to the environment and the people around it. The SBP was measured 7 times consecutively, with the highest and lowest values discarded. The final SBP value was represented by the average of the remaining 5 measurements. The obtained final values were compared to those reported in specialized literature Classification in appropriate hypertension degrees was based on the ISFM guidelines.

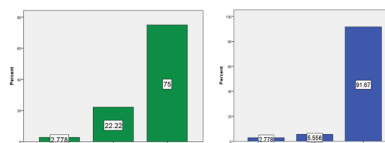
The SPSS18 software was used for the statistical analysis, while determination of significant differences in the case of quantitative variables was performed using ANOVA.

• Results and discussions

	Paired Differences				t	df	Sig. (2-tailed)		
	Mean	Std. Deviation	Std. Error	95% Confidence Interval of the Difference					
Lower									
Upper									
Pair 1	TAS - TAS-D	-13.95566	14.59245	2.43208	-18.49293	-8.61810	-5.574	35	0.000



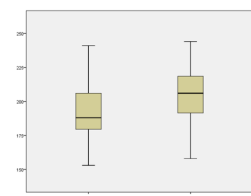
Graphical representation of values obtained following the comparison of SBP and D-SBP



Representation of categorization into hypertension grades based on values measured through the oscillometric method

Representation of categorization into hypertension grades based on values measured through the Doppler ultrasonographic method

	N	Minimum	Maximum	Mean	Std. Deviation
TAS	36	153.00	241.00	192.6111	21.62839
TAS-D	36	158.00	244.00	206.1667	19.42531
Valid N (listwise)	36				



Box-Plot diagram representing the average values of SBP and D-SBP

- there are significant differences between the mean SBP and SBP-D values ($P=0.000 < P=0.05$)
- the standard deviation for the oscillometric measurement was larger than that for the Doppler ultrasonographic measurement
- the distribution of groups obtained for hypertension grades based on values measured through the oscillometric method did not differ significantly statistically from the ones measured through the Doppler ultrasonographic method (Fisher's Exact Test = 3.897, $p = 1.000 > 0.05$)

The above-mentioned indirect monitoring techniques provide good alternatives to direct arterial BP evaluation in certain populations. The greatest limitation of indirect monitoring is its inaccuracy, particularly in hypotensive or hypertensive animals and in certain species. Perhaps the biggest challenge veterinarians face when using indirect monitors is recognizing the accuracy, or inaccuracy, of the results and how they should be interpreted. Critical evaluation of the reference literature is important. Non-invasive monitors can vary in performance and blood pressure values differ across veterinary species and if an animal is conscious or anesthetized; therefore, findings of monitor performance in one study cannot be extrapolated to another species nor can findings in conscious animals be translated to anesthetized animals.

There were several limitations to our study including the small population size and the use of a single machine for evaluating each method. Most importantly, we were unable to undertake direct BP readings and, therefore, cannot qualify the accuracy of our results throughout this study. We consider the Doppler machine superior to the oscillometric machine for measuring SBP in cats, in terms of ease of use and repeatability of results, and speed of use and diagnosis of systemic hypertension, but we cannot pronounce on the repeatability of the results, which could not be demonstrated.

• Conclusions

Blood pressure can be measured in conscious cats using both oscillometry and Doppler ultrasonic methods. Significantly different blood pressure values were obtained between the two methods which argues for caution in their alternative use in monitoring the condition of hypertensive cats.

Even though the two methods can provide the veterinarian with a good tool for routine monitoring or staging of arterial hypertension, extensive studies are needed to establish their accuracy with certainty.