Comparison between the Parks Medical Doppler and the Mano Médical Vet BP Doppler for recording indirect systemic blood pressure in conscious dogs

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†Sadly, Dr Jonathan Bouvard died in 2021; we therefore dedicate this paper to him.

Abstract

Background: The acquisition of systemic blood pressure (SBP) provides valuable information regarding cardiovascular function and tissue perfusion in human and veterinary species. This measurement is a fundamental part of the clinical assessment for those patients in which disturbances of blood pressure are a possibility (Hsiang et al., 2008; Vachon et al., 2014).

Aim: To evaluate the agreement between Parks Medical Doppler (PMD) and Mano Médical Vet BP (MMVP) Doppler for assessing SBP in conscious dogs.

Methods: 40 client-owned dogs were prospectively enrolled; SBP measurements were acquired by a single operator using the PMD and then the MMVP. The mean of five consecutive measurements for each device was classified according to target organ damage (TOD) risk scores (1: <140 mmHg; 2: 140–160 mmHg; 3: 160–180 mmHg; 4: ≥ 180 mmHg).

Results: Total mean SBP for the devices was not statistically different (p = 0.77). However, the Bland–Altman analysis revealed wide limits of agreement (LoA), with MMVP slightly underestimating SBP compared to PMD (bias = −0.6 mmHg, 95% LoA: −26.3 to 25.09). Both devices correlated well (r = 0.8269; p < 0.0001) and had identically acceptable intra-observer repeatability (coefficients of variation = 4.09% for MMVP and 3.86% for PMD). Four dogs (10%) had a TOD score of 3 by one device but scored <3 with the other.

Conclusion: A good agreement and correlation was observed between the PMD and the MMVP, suggesting that both devices can be used interchangeably for assessment of SBP in conscious dogs. The wide LoA observed between both devices was most likely associated with intraindividual variability in SBP over time.

Keywords: Conscious, Dogs, Doppler, Systemic blood pressure.

Introduction

The acquisition of systemic blood pressure (SBP) provides valuable information regarding cardiovascular function and tissue perfusion in human and veterinary species. This measurement is a fundamental part of the clinical assessment for those patients in which disturbances of blood pressure are a possibility (Hsiang et al., 2008; Sansom and Bodey, 1997; Finco, 2004; Haberman et al., 2006). Measurement of SBP can be accomplished by using a direct invasive method or an indirect noninvasive method (Stepien and Rapoport, 1999). The direct invasive method is considered the gold standard for blood pressure measurement in veterinary patients (Bodey et al., 1996; Wagner and Brodbelt, 1997; Stepien and Rapoport, 1999; Bosiack et al., 2010); however, it is usually obtained via intra-arterial catheterization, which requires specialized equipment and operator’s expertise. Moreover, this method can be challenging to perform in a conscious veterinary patient, where it can cause some discomfort, making it impractical to apply in clinical practice (Wagner and Brodbelt, 1997; Bosiack et al., 2010; Vachon et al., 2014). For this reason, noninvasive indirect blood pressure (NIBP) methods involving the use of an inflatable cuff and a detection device, such as Doppler ultrasonography and oscillometry, are more commonly used (Haberman et al., 2006; Vachon et al., 2014).

Currently, there are numerous commercially available NIBP devices used to measure SBP in veterinary patients. However, none of these devices meet the published human validation criteria when used in conscious dogs (Acierno et al., 2018). The Parks Medical Doppler (PMD) is one of the most commonly used Doppler ultrasonography devices in veterinary practices across the world and is considered an appropriate device for NIBP measurement in conscious dogs (Haberman et al., 2010).
et al., 2006; Acierno et al., 2018). Its discontinuation from the market has prompted the need for other Doppler devices to be considered as its replacement. The Mano Médical Vet BP (MMVBP) Doppler (Mano Médical) is one of the new devices currently on the market. It benefits in its portability (compact dimensions: 0.3 kg), user-friendly interface, as well as cost-effectiveness. A consistent and comparable performance by this device might allow it to be a suitable alternative to the PMD for SBP assessment in clinical practice.

We hypothesized that the MMVBP and PMD devices can be used interchangeably. To investigate this hypothesis, we evaluated the intra-observer repeatability and the level of agreement between SBP measurements obtained with the two devices when used on conscious dogs. Since there could be no comparison with direct blood pressure assessment, the study did not aim to validate these indirect devices.

Materials and Methods

Animals

Client-owned dogs referred for various medical reasons were considered for enrolment if they underwent conscious SBP measurements as part of their medical work-up. Owner consent was obtained for all participants. Dogs in which compliance was not adequate and in which the likelihood of developing handling-associated stress was high, were not included in the study, as this could contribute to significant variations in SBP, making interpretation of these readings challenging (Remillard et al., 1991). Moreover, dogs were also excluded if their participation in the study could be detrimental for their physical or mental health. Dog’s sex, age and breed were collected from the patient’s medical files.

Blood pressure measurements

All SBP measurements were obtained by a single operator in accordance with the American College of Veterinary Internal Medicine (ACVIM) consensus statement, using the same experienced handler and assistant in every case (Acierno et al., 2018). A total of six consecutive SBP measurements were carried out on all dogs with each of the two Doppler ultrasonography devices studied (811- BL; Parks Medical Electronics and Vet DP Doppler; Mano Médical); both devices were calibrated and operated according to their manufacturer’s guidelines. The PMD was the first device used in all cases. For each device, the first reading obtained was discarded (Acierno et al., 2018). The mean of five SBP values was then calculated for each device and divided according to the target organ damage (TOD) risk-scoring system (1: < 140 mmHg; 2: 140–159 mmHg; 3: 160–179 mmHg; 4: ≥ 80 mmHg) as suggested by Acierno et al. (2018). Hypotension was defined as a mean SBP < 120 mmHg (Acierno et al., 2018).

Stress and anxiety were minimized by performing SBP measurements with minimal stress and gentle handling, in a quiet room, allowing a 5-minute period of acclimation to the surroundings before and between each set of measurements (Acierno et al., 2018). Dogs were gently restrained in sternal recumbency in an attempt to ensure positioning of the cuff at the level of the heart base. For practical purposes, one forelimb was chosen, and the same limb was used for all consecutive measurements.

A small patch of fur, over the ulnar artery of approximately 2 cm², was clipped below the carpal pad of the selected limb. An inflatable cuff (FlexiPort® Disposable Blood Pressure Cuffs; Welch Allyn) with a width of approximately 30%–40% of the circumference of the chosen forelimb (measured by using a soft measuring tape) was placed on the antebrachium, in accordance to the ACVIM consensus statement (Acierno et al., 2018).

Care was taken to place the center of the inflatable part of the cuff on the medial aspect of the limb and the air tube on the distal end of the cuff. The concave side of the piezoelectric crystal was then covered with coupling gel and placed on the skin, distal to the cuff at the level of the previously clipped area. The pressure holding the probe in place and volume control were finely adjusted until the pulse was heard clearly through the speaker. The cuff was inflated to occlude arterial pressure until no sound was heard using a sphygmomanometer. The cuff was gradually deflated to allow return of flow through the artery until the first sound was heard at systolic pressure.

Statistical analysis

Statistical analysis was conducted using a commercially available statistical software (Prism 8, version 8.2.1). Data were assessed for normality graphically and tested by using the Shapiro–Wilk normality test. Continuous variables were reported as mean ± standard deviation (SD), if normally distributed, and as median and ranges, if not normally distributed.

For all dogs, a single pair of measurements was used for analysis. The mean SBP from each set of five measurements obtained with both devices was calculated. Sets of pairs of values were compared with paired t-tests. Bias and limits of agreement (LoA) between both devices were assessed by a Bland–Altman plot. For the purpose of this study, “good agreement” was defined as a difference of ≤ 10 mmHg between the mean SBP obtained from both devices. Correlation (r) between the devices was determined by the Pearson correlation test and defined as excellent if r ≥ 0.90, very good if 0.90 > r ≥ 0.70, good if 0.70 > r ≥ 0.50, or poor if r < 0.50 (Hinkle et al., 2003). Coefficients of variation (CV) were defined as the SD of the differences divided by the mean of the variable under consideration and were expressed as a percentage. Values < 15% were considered adequate for clinical use (Chetboul, 2015). A two-sided alpha of p < 0.05 was considered to be statistically significant.

Ethical approval

This prospective study, approved by our local ethics committee (approval no. 1208741), was conducted at
the Royal (Dick) School of Veterinary Studies over 3 weeks.

Results

A total of 40 dogs were enrolled in the study. The study population consisted of Labrador Retriever (n = 9), Cocker Spaniel (n = 8), mixed breed (n = 4), Staffordshire Terrier (n = 3), Lhasa Apso (n = 2), Chihuahua (n = 2), Bulldog (n = 2), Chinese Crested (n = 1), Dogue de Bordeaux (n = 1), Burmese Mountain (n = 1), Poodle (n = 1), Border Terrier (n = 1), Beagle (n = 1), Yorkshire Terrier (n = 1), Collie (n = 1), Maltese (n = 1), and Patterdale Terrier (n = 1) breeds. There were 26 females (23 neutered and 3 intact) and 14 males (9 neutered and 5 intact). The median weight was 16.75 kg (range: 2–52.6) and the median age was 5.1 years (range: 0.2–13).

When comparing the two devices, the CVs obtained with the MMVBP and the PMD were 4.09% and 3.86%, respectively. The overall mean SBP measured by the PMD and by the MMVBP were 153.3 ± 3.2 and 152.6 ± 3.7 mmHg, respectively; the means were not significantly different (p = 0.77). The mean SBP values acquired with both devices differed from each other by < 10 and 20 mmHg in 70% and 93% of dogs, respectively.

The correlation between sets of mean SBP values obtained from each device was very good (r = 0.8269; p < 0.0001) (Fig. 1). With the Bland–Altman analysis, MMVBP slightly underestimated SBP compared to PMD with a wide level of agreement (bias = -0.6 ± 13.1 mmHg, 95% LoA: -26.3 to 25.09) (Fig. 2).

The TOD risk SBP scoring system classified 13 dogs with a score of 1, 13 with a score of 2, 8 with a score of 3, and 6 with a score of 4. Two of the dogs assigned with a score of 3 with the MMVBP device were scored with a score of < 3 (one with a score of 2 and the other with a score of 1) with the PMD device. The contrary also occurred: two of the dogs assigned with a score of 3 with the PMD device were scored with a score of < 3 (one with a score of 2 and the other with a score of 1) with the MMVBP device. No dogs were defined as hypotensive in the present study.

Discussion

The assessment of SBP in conscious veterinary patients is commonly achieved by noninvasive indirect methods. The PMD, for instance, is one of the most commonly used Doppler ultrasonography devices in veterinary practices across the world and is considered to be a reliable tool for the acquisition of SBP measurements in conscious dogs (Acierno et al., 2018). Its recent discontinuation from the market has prompted the need for replacement devices to be considered; however, data regarding the agreement between different Doppler devices is currently limited. The aims of the present study were to compare two Doppler devices, the PMD and the MMVBP, for the measurement of SBP in conscious dogs in the clinical setting.

In this study, SBP analysis was performed in a total of 40 conscious dogs, and the mean SBP readings provided by the two Doppler devices were not statistically different. The correlation between devices was observed to be very good, reflecting that a change in SBP detected by the MMVBP likely reflects an identical change with the PMD device.
measurements obtained from the same dog over time (taking intraindividual variability in SBP into account). There were a number of limitations in this study. The small study population could have impacted on the level of agreement between the devices by decreasing the statistical power; a narrower level of agreement might have been seen if more dogs had been enrolled. While this is a potential limitation, lower sample numbers have been previously used in similar studies (Jepson et al., 2005; Chetboul et al., 2010; Wernick et al., 2012a). The inclusion of more dogs with an SBP ≥ 180 mmHg would have allowed for a more accurate evaluation of the agreement between devices under high SBP conditions (only eight dogs had an SBP ≥ 180 mmHg). There were also few dogs with a low SBP, but they were excluded because assessment could have" should be "There were also few dogs with low SBP because these were excluded if assessment could have" The aim of this study was not to validate the MMVBP. Further research in which the performance of the MMVBP is compared to the gold standard direct method, ideally in conscious dogs, is needed to elucidate the device’s accuracy (Haberman et al., 2006; Seliskar et al., 2013). This would hopefully allow for refinement of the validation criteria for this device, as well as for the establishment of monitor-specific reference intervals (Jepson et al., 2005; Acierno et al., 2018).

Conclusion
In conclusion, the results of the present study suggest that the MMVBP and the PMD can be used interchangeably for assessment of SBP in conscious dogs. The wide LoA observed between both devices were most likely associated with intraindividual variability in SBP over time. Clinicians should be aware of the possibility for clinically relevant discrepancies between sets of SBP measurements obtained at different times with either device.

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