

EVALUATION OF HDO® (HIGH DEFINITION OSCILLOMETRY) – A NEW NON-INVASIVE BLOOD PRESSURE TECHNIQUE – IN COMPARISON TO INVASIVE MEASUREMENT (HSE-HYDRO SACHS ELECTRONICS) IN ANESTHETISED DOGS



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Abstract

Precise measurement of high and low blood pressure is vital in veterinary medicine. This is especially the case if cardiac output is affected such as with shock or arrhythmias. Accurate blood pressure information can be a vital parameter influencing treatment decisions and thereby survival. So far available NIBP technologies had clear limitations¹. Invasive techniques are regarded as the gold standard however, these are often not clinically applicable in many practices. High Definition Oscillometry (HDO) was evaluated against direct blood pressure as a potential non-invasive alternative. A significant correlation for SAP ($r = 0.895$; $p < 0.001$) and DAP ($r = 0.875$; $p < 0.001$) was observed. These results were obtained over a wide variety of situations including severe arrhythmias, high and low heart rates (49 – 210 bpm) and blood pressure fluctuation of 67-310 SAP, thus HDO may be regarded as a clear alternative for invasive methods.

Introduction and Hypothesis

High Definition Oscillometry (HDO) is a novel technology, providing real-time data acquisition and data analysis, resulting in real-time display and beat-to-beat presentation of the pulse waves on a computer screen (Fig. 1). The analysis is not limited to just blood pressure – it also visualizes brady- and tachycardic patients with or without arrhythmia and allows detailed analysis of each single pulse wave on screen via the included software. This indicates, that HDO might be a future non-invasive cardio-vascular evaluation monitor not limited to measure just blood pressure, but further more pulse pressure, cardiac output and arterial compliance. In this first study, HDO accuracy for measuring blood pressure non-invasively should be determined in comparison to Gold standard invasive method^{2,3}.

Material and Methods

7 beagle dogs were anesthetized (propofol) and blood pressure was affected by using the following drugs phenylephrine, dopamine or isoflurane (Fig. 3). Systolic, mean, diastolic arterial blood pressure (SAP/MAP/DAP) and pulse/min (bpm) were determined 75 times within 120 Minutes per individual. The selected HDO cuff was D1 – (for dogs weighing 10–25 kg). No measurement of circumference of the measurement site was necessary, as HDO detects cuff-volume and information on arterial diameter during the first reading leading to the relevant parameter adjustments automatically. The cuff position was evaluated in a pilot study and showed similar results on the contra-lateral leg as it did on the tail. As in a practical environment, the tail is the preferred position, the comparison was done with a cuff placed on the base of the tail and the invasive direct line (HSE, Millar Catheter 3 French SPR249) was placed in the cranial tibial artery (Fig. 4 + 5). Direct Line(HSE) system measures MAP and SAP but calculates DAP. HDO measures all 3 pressures parameters. This indicates that the comparison of DAP might be a limitation on the invasive unit.

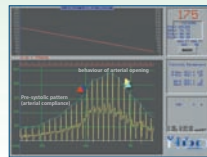


Figure 1a HDO graphical display showing, that direct (SAP, DAP) match with HDO readings (SAP, DAP)

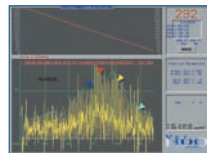


Figure 1b In severe arrhythmia invasive method was misled occasionally.

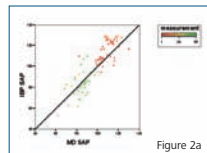


Figure 2a

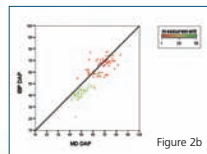


Figure 2b

Figure 2 Scatter plots of non invasive pressures (MD=HDO) versus direct pressures (IBP) for overall measures: (a) Systolic arterial pressure (SAP) and (b) diastolic arterial pressure (DAP)

Statistical Evaluation

Mean, standard deviation (SD) and standard error of the mean (SEM) were calculated for the measurements. The agreement of the noninvasive SAP and diastolic arterial pressure (DAP) with the corresponding simultaneous invasive values were analyzed according to the Bland-Altman method^{4,5}. The mean difference (bias) and standard deviation (SD) of the difference (precision) were calculated by subtracting the values from the HDO technique from the corresponding HSE direct arterial pressure values.

Results

75 sequential measurements were analysed in each dog. With increasing number of readings, blood pressure values (DAP, SAP) decreased using both direct and indirect measuring methods (see Figure 2a+b).

The best agreement between the two methods was found to be SAP. Within single animals, a significant correlation between the measurement methods for SAP was observed (correlation coefficient $r = 0.895$; $p < 0.001$). Mean difference between the two methods was 0.18 ± 9.15 mmHg ($p = 0.632$, see Figure 2a). Also for DAP a significant correlation between the two methods was investigated ($r = 0.875$; $p < 0.001$) with a mean difference of 5.6 ± 7.3 mmHg, $p < 0.001$, see Figure 2b).

References

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Figure 3 Drugs and Material



Figure 4 Cuff and catheter placement



Figure 5 Set up of HSE and HDO monitors

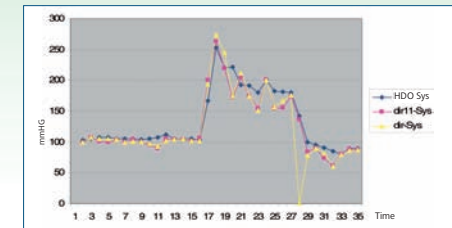


Figure 6 Correlation of SAP in hypotensive and hypertensive situations with severe arrhythmia (17 – 26)

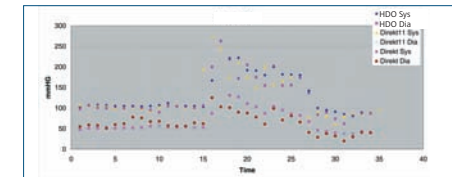


Figure 7 Correlation of all values

Summary and Conclusion

- ▶ HDO demonstrates feasibility and reproducibility of non-invasive blood pressure measurements.
- ▶ Data determined by HDO non-invasively corresponds to those results gained by HSE invasively.
- ▶ Measurements taken in arrhythmic situations demonstrate that the speed of analysis of HDO (32 bit) vs HSE (8bit) offers significantly faster reaction on cardiac output related blood pressure changes and thus more accurate determination of real pressures.
- ▶ Visualisation of single pulse waves and the entire opening behaviour of the artery might open new dimensions in overall cardio-vascular evaluation of patients, especially but not limited to patients with heart, renal disease and diabetes.