Bioimpedance technology: Use and repeatability in canines

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Kellogg Honors College Capstone Project

Abstract

Bioimpedance technology uses an electrical current of 800 uA and a frequency of 50kHz to measure the voltage drop between electrodes placed across the body. Bioimpedance technology has potential for becoming an efficient and practical tool in the field of veterinary medicine. Bioimpedance technology gives rise to an objective and quantitative way of evaluating body condition. The technology coefficients used by the instrument for calculations were 1.05 for body density, 0.732 for the hydration constant, 1.00 for cylindrical body proportion, 324.9 for extracellular fluid resistivity and 751.8 for intracellular fluid resistivity. Using an electrical impulse and four alligator clips (two sense and two current leads) the Impedivet instrument gives specific body measurements including: fat mass, fat-free mass, and intracellular and extracellular fluid. The novelty of the technology requires tests to confirm accuracy and repeatability of the device. The goal of this project is to determine the repeatability of the device by taking multiple measurements from a large group of canines.

Introduction

- The Impedivet uses electrical impulse flow through the body, between sense and current leads to produce values of body composition
- Fat mass percent was the main component of interest in this study
- Five canines tested at two locations were used to determine variability of measurements between placements
- The Impedivet device was used on 11 canines to evaluate the correlation between body condition score (BCS) and fat mass percentage determined by the Impedivet

Results

- The fat mass percentages given in the axilla-axilla location were higher in three of the five canines compared to the axilla-inguinal location
- Fat mass percentages were higher in the axilla-inguinal area in one of the five canines, compared to the axilla-axilla location
- Fat mass percentages were the same in the axilla-axilla location and the axilla-inguinal location in one of the five canines
- The variation in measurements in a single location was higher in the axilla-axilla location compared to the axilla-inguinal location in all five of the canines
- The values given for fat mass percent for each canine were grossly overestimated
- BCS and fat mass percent had no correlation

Methods and Materials

- Five canines were used in the evaluation of two lead placement locations: right axilla (yellow and red lead) and left axilla (blue and black lead), and left axilla (blue and black lead) and left inguinal area (red and yellow lead). With the canine in a standing position, five measurements were taken in each location with removal and replacement of the leads between measurements. The average between measurements in each location was graphed and error bars were included to determine error between measurements at a location.
- Eleven canines were used in the evaluation of fat mass percentage from the Impedivet and a BCS was given to each canine. The blue and black lead were placed in the left axilla, and the red and yellow lead were placed in the left inguinal area of each dog, and a single measurement was taken to determine fat mass percentage. The BCS of the animal and fat mass percentage were used in a graph of the data. The validity of each measurement was proven with a Cole plot on the Impedivet.

Figure 1. Impedivet Device

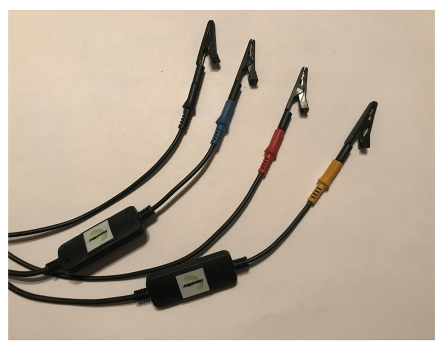


Figure 2. Four leads used to clip onto canines

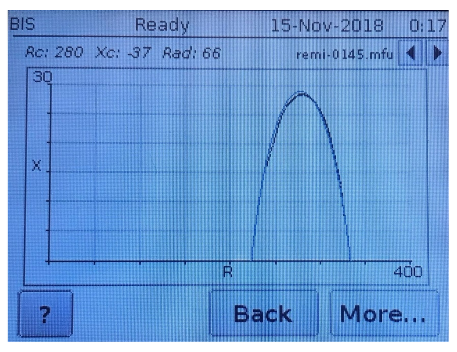


Figure 3. Valid Cole plot

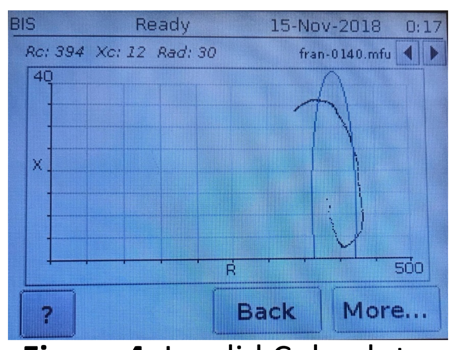


Figure 4. Invalid Cole plot

Figure 5. Average fat mass % at each location in the 5 canines used for repeatability

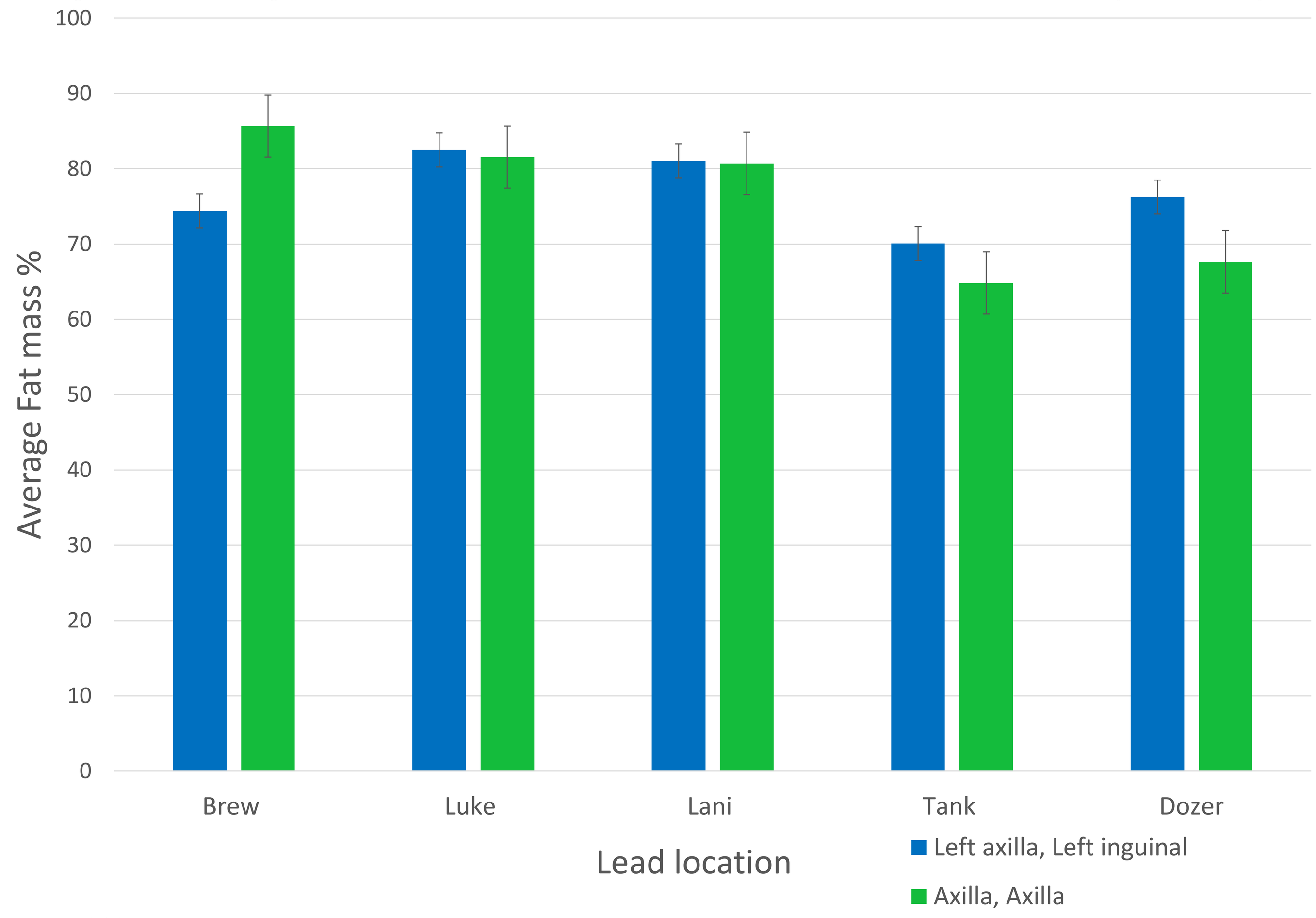


Figure 7. Axillary and inguinal area depicted

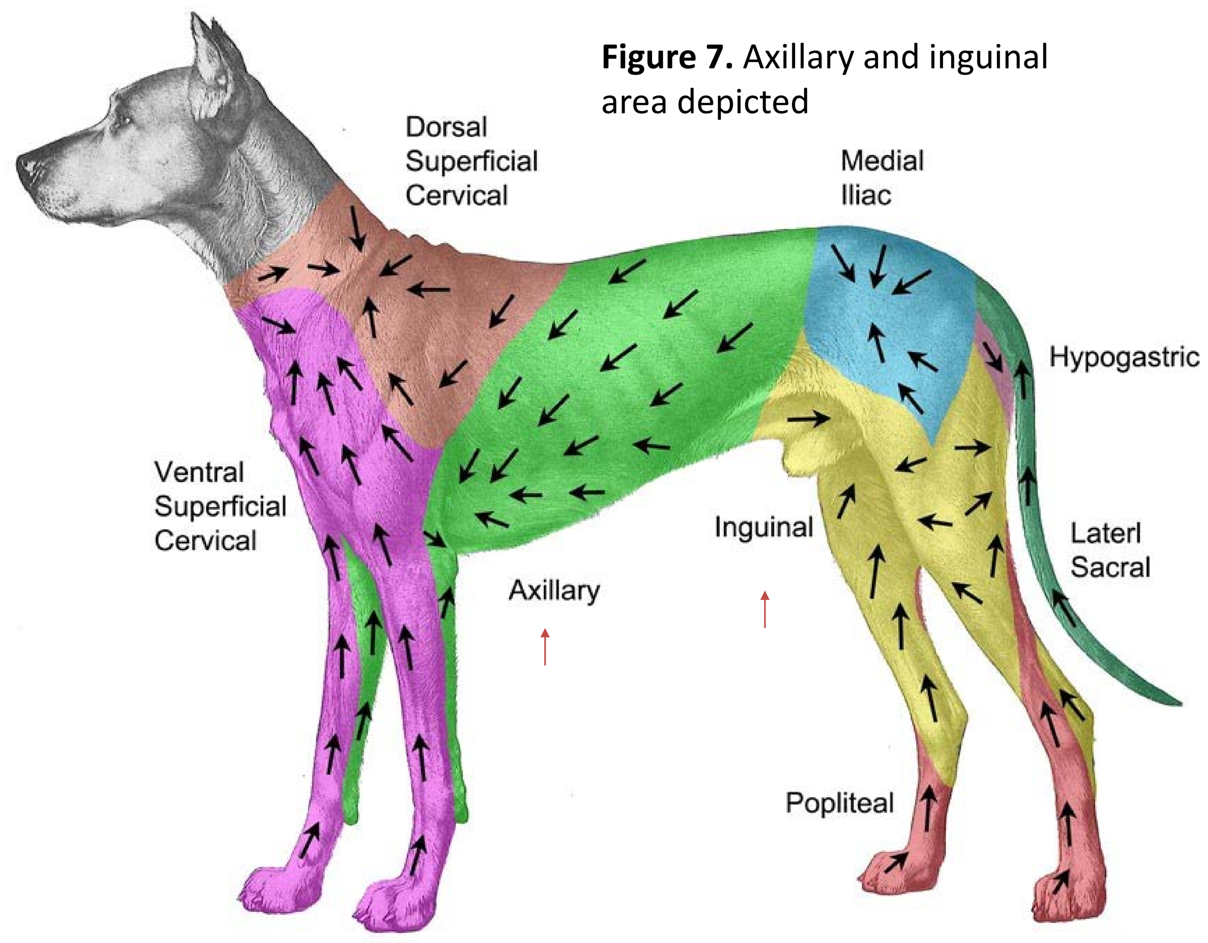


Figure 8. BCS vs fat mass % in 11 canines. Each bar represents an individual dog

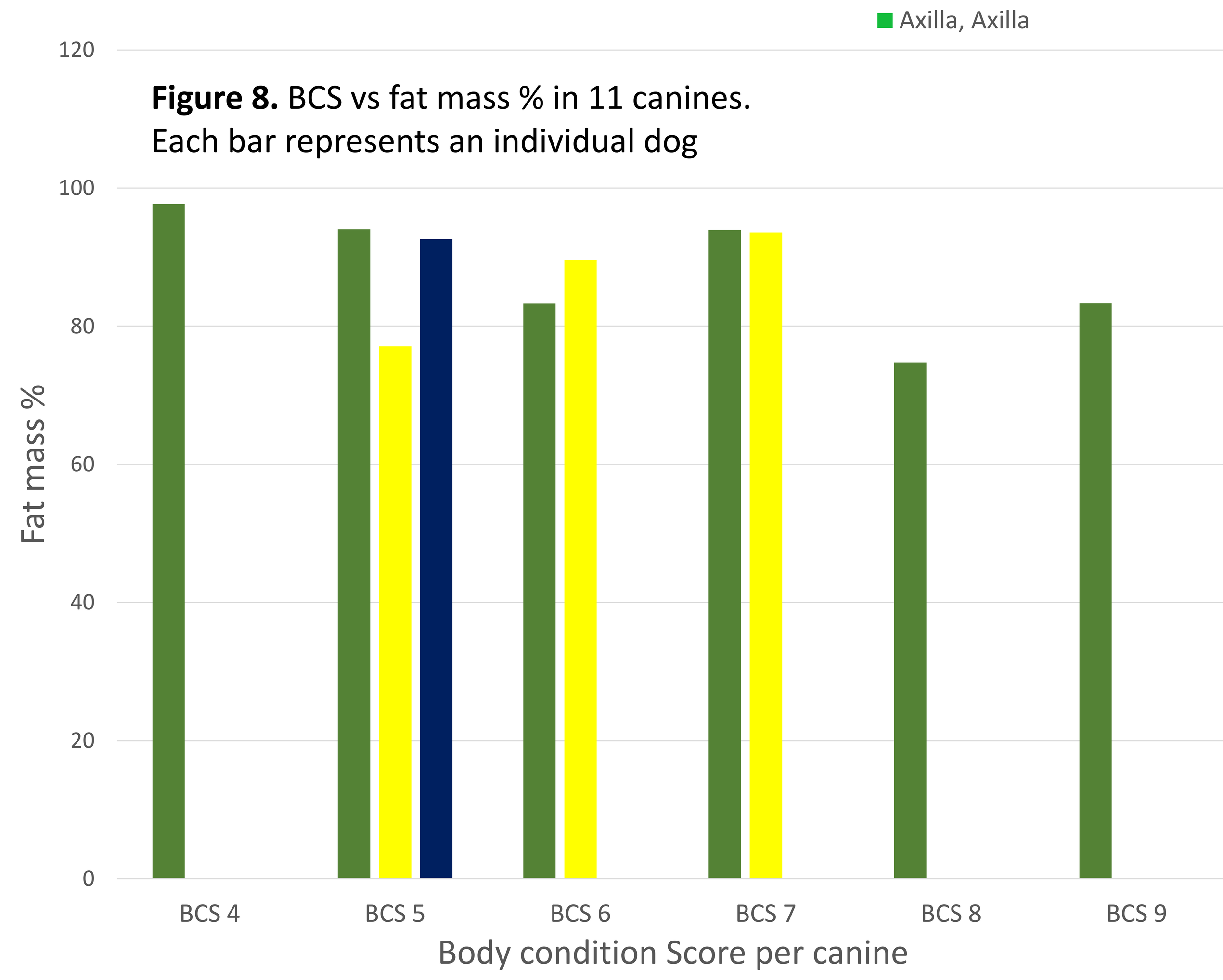
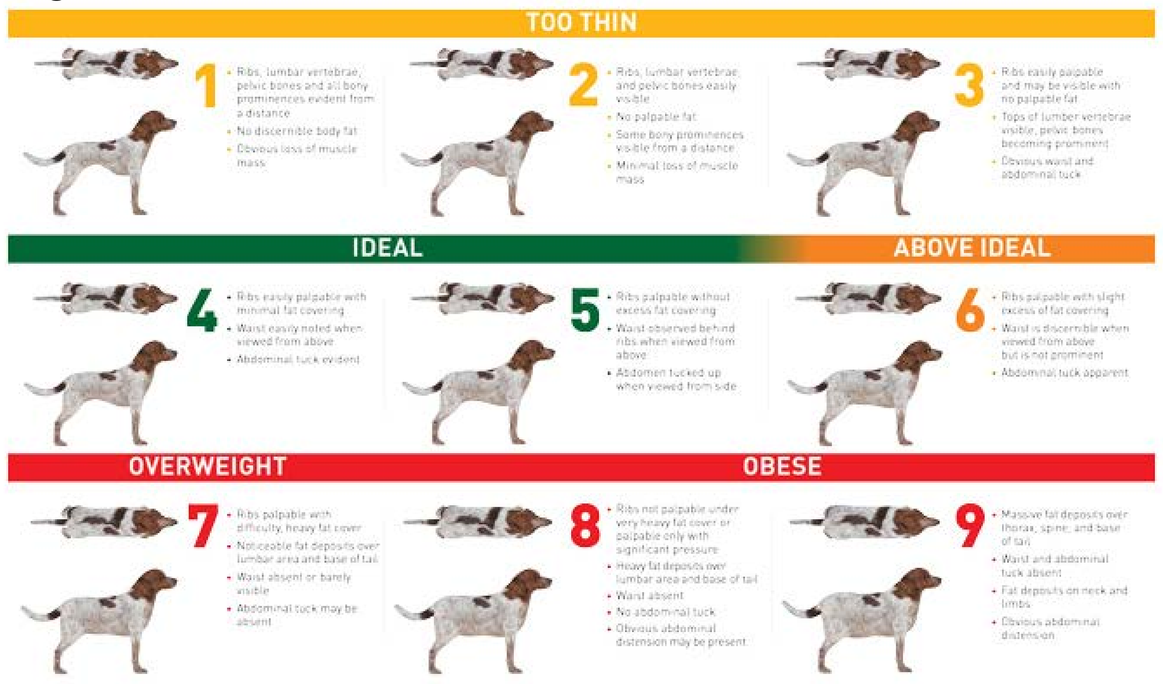


Figure 6. BCS chart 1-9



Discussion

- The difference in fat mass percent given in each location seemed to be consistently lower in the axilla, axilla location.
- The error bars among measurements taken in the axilla-axilla location were higher. This was different than expected considering there was less distance between the leads compared to the axilla-inguinal location
- There was no trend seen between BCS and fat mass percent. Ideally as BCS increased fat mass percent should increase; however, this was not seen. A canine with a BCS of 4 had a higher fat mass percent than a canine with a BCS of 9.
- The gross overestimation of values is most likely due to the intracellular and extracellular resistivity coefficients being those for rats

Future Directions

- Intracellular and extracellular resistivity coefficients should be determined for varying canine breeds and genders
- Increase sample size

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References

1. The importance of assessing body composition of dogs and cats and methods available for use in clinical practice. Amanda Santarossa, Jacqueline M. Parr, and Adronie Verbrugghe. Journal of the American Veterinary Medical Association 2017 251:5, 521-529
2. Comparison of a bioimpedance monitor with dual-energy x-ray absorptiometry for noninvasive estimation of percentage body fat in dogs. Alexander J. German, Shelley L. Holden, Penelope J. Morris, and Vincent Biourge. American Journal of Veterinary Research 2010 71:4, 393-398
3. Denise A. Elliott, Robert C. Backus, Marta D. Van Loan, Quinton R. Rogers; Evaluation of Multifrequency Bioelectrical Impedance Analysis for the Assessment of Extracellular and Total Body Water in Healthy Cats, The Journal of Nutrition, Volume 132, Issue 6, 1 June 2002, Pages 1757S–1759S, https://doi.org/10.1093/jn/132.6.1757S

Acknowledgements

Cord Brundage, PhD, DVM
Impedivet®
Kellogg Honors College at Cal Poly Pomona