Article

Comparison between auricular and standard rectal thermometers for the measurement of body temperature in dogs

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Abstract — Although the rectal mucosa remains the traditional site for measuring body temperature in dogs, an increasing number of clinicians have been using auricular temperature to estimate core body temperature. In this study, 88 mature healthy dogs had body temperatures measured with auricular and rectal thermometers. The mean temperature and confidence intervals were similar for each method, but Bland-Altman plots showed high biases and limits of agreement unacceptable for clinical purposes. The results indicate that auricular and rectal temperatures should not be interpreted interchangeably.

Résumé — Comparaison entre les thermomètres auriculaires et rectaux standard pour la mesure de la température corporelle chez les chiens. Même si les muqueuses rectales demeurent le site traditionnel pour la mesure de la température corporelle chez les chiens, un nombre grandissant de cliniciens utilisent la température auriculaire pour estimer la température corporelle centrale. Dans cette étude, la température de 88 chiens adultes en santé a été mesurée à l'aide de thermomètres auriculaires et rectaux. La température moyenne et les intervalles de confiance étaient semblables pour chaque méthode, mais les représentations graphiques Bland-Altman ont montré des biais élevés et des seuils de concordance inacceptables à des fins cliniques. Les résultats indiquent que les températures auriculaires et rectales ne devraient pas être interprétées de manière interchangeable.

(Traduit par Isabelle Vallières)

Can Vet J 2011;52:403–406

Introduction

Measuring body temperature allows the identification of variations of core temperature associated with medical conditions (1). Body temperature in dogs has traditionally been obtained by using rectal thermometers. Besides being stressful for many dogs, use of rectal thermometers is time-consuming and can be a potential source of cross-contamination and injury to the patient and the veterinarian (2–4). Moreover, many conditions, including digestion, peristaltic movements, fecal masses, muscle tone, and physical activity may affect temperatures acquired by rectal thermometry (5).

Several types of clinical thermometers are available, including non-contact non-invasive, mildly-invasive contact, and invasive contact devices. The latter are used more frequently in anesthetized and critical care patients. Most often, dogs have their body temperature obtained by placing a mildly invasive contact thermometer, such as a glass thermometer or a digital thermometer, against the rectal mucosa for varying lengths of time (1,3,6).

Recently there has been an increase in the use of non-contact non-invasive thermometers, such as the infrared auricular thermometer, presumably because of the shorter time needed to obtain body temperature, the supposed accuracy, and better patient compliance in dogs and cats (1,4). These thermometers utilize pyroelectric sensors to detect the temperature of the tympanic membrane, which theoretically provides a more accurate measurement of core body temperature (7,8).

Studies have shown varying results when comparing auricular with rectal temperatures. In many studies, however, only a small number of animals was assessed (1,4,9). In this study, therefore, we hypothesized that a correlation exists between auricular and rectal temperatures in a large population of clinically healthy dogs.

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Materials and methods

Animals

Eighty-eight adult dogs [mean weight 13.2 kg ± 11.8 kg (standard deviation, *s*)] of either sex were used. Several breeds were represented. All animals enrolled in the study were brought to a Veterinary Teaching Hospital for various purposes, including routine vaccinations and neutering. Written consent was obtained from the owners and all animals were determined to be healthy based on physical examination. Once the temperatures

Table 1. Temperatures (°C) measured by auricular and rectal thermometers in 88 clinically healthy dogs

Type of measurement	Mean	*s*	95% CI
Mercury thermometer — column stabilization	38.6	0.5	38.5, 38.7
Mercury thermometer — 3 minutes	38.8	0.4	38.7, 38.9
Digital thermometer	38.7	0.4	38.6, 38.8
Auricular thermometer (1st observer)	39.0	0.5	38.9, 39.1
Auricular thermometer (2nd observer)	39.0	0.6	38.9, 39.2

s — standard deviation; CI — confidence interval.

Table 2. Bias and limits of agreement (°C) between temperatures measured by auricular and rectal thermometers in 88 clinically healthy dogs

Type of measurement	Bias	*s*	95% limits of agreement
Mercury thermometer — column stabilization	−0.4011	0.4762	−1.335, 0.5322
Mercury thermometer — 3 minutes	−0.1716	0.4604	−1.074, 0.7307
Digital thermometer	−0.3182	0.4409	−1.182, 0.5460

s — standard deviation.

had been obtained, the animal was returned to its owner. The study was conducted in accordance with guidelines outlined in the National Institutes of Health *Guide for the Care and Use of Laboratory Animals*.

Temperature measurements

Body temperatures were obtained in a room that had a mean temperature of 26.2°C ± 0.1°C and relative air humidity of 67.0% ± 17.2%. Each animal was acclimatized to the temperature in the room for 30 min before measurements were taken.

Commercially available thermometers were used, including an auricular infrared device (Thermoscan IRT 4520; Braun, Kronberg, Germany), a glass-mercury thermometer (Accumed; G-Tech, São Paulo, Brazil), and a digital equilibrium thermometer (Digital Soft Tip; CVS, Woonsocket, Rhode Island, USA). After being positioned in the ear canal descending to the eardrum, the activation push-button was pressed and the auricular infrared thermometer provided readings within seconds. The rectal glass-mercury thermometer was inserted a minimum of 2 cm into the rectum, and kept in contact with the rectal mucosa either until an apparently steady temperature was observed (stabilization of the mercury column) or for 3 min. The digital thermometer was also inserted a minimum of 2 cm into the rectum, where it remained until an endpoint reading audible beep was heard. Prior to the study, accuracy of both rectal thermometers was validated in a temperature controlled water bath against a reference thermometer. A temperature controlled thermal plate was used to validate the auricular thermometer.

Four temperatures were obtained by the same experienced observer in the following order: 1) rectal glass-mercury thermometer for 3 min, 2) auricular thermometer, 3) rectal digital thermometer, and 4) rectal glass-mercury thermometer until stabilization of the column (steady temperature). A second experienced observer independently performed a second measurement of auricular temperature at the end of the 4 initial readings.

Statistical analyses

The results are expressed as the mean, standard deviation *(s)*, and 95% confidence intervals (CI). The agreement between auricular and rectal temperatures was assessed using Bland-Altman, in which the difference between 2 techniques (auricular versus rectal) is plotted against their mean and the limits of agreement calculated (10). The same method was used to assess how the several rectal temperatures compare with each other. Pearson's correlation coefficient was calculated between all rectal temperatures and auricular measurements, as well as between the results of auricular temperatures obtained by the 2 observers.

Results

Table 1 gives the results of mean, *s*, and 95% CI of both auricular and rectal temperatures. Measurements were obtained by the 4 protocols in every animal. Auricular measurements were well-tolerated in 89.7% of the dogs, whereas rectal measurements were well-tolerated in only 68.2% of the dogs. The maximal temperatures documented for auricular and rectal thermometers were 40.3°C (auricular), 39.9°C (glass-mercury for 3 min), 39.5°C [glass-mercury thermometer (steady state)], and 39.5°C (digital). Signs attributable to fever were not documented in any dog.

Bland-Altman plots revealed a better agreement between auricular temperatures and rectal measurements using the glass-mercury thermometer for 3 min (Table 2). The bias, or average difference between the 2 methods, was −0.1716°C, with limits of agreement showing that the discrepancy between auricular and rectal (glass-mercury for 3 min) temperatures for an individual animal ranged from −1.335°C to 0.532°C. If we arbitrarily consider any error > ± 0.50°C to be clinically unacceptable, then there is a lack of agreement between the 2 types of body temperature measurements. The other 2 types of rectal temperatures showed even greater biases, also failing to agree with auricular readings. Bland-Altman plots showed that the differences in temperature (auricular minus rectal) are not close to zero, thereby indicating that the tested methods do lack agreement. Also, Bland-Altman was used to assess how the several rectal temperatures compare with each other (Table 3), showing much narrower ranges for the limits of agreement.

Pearson's correlation coefficient (r^2) indicated a weak correlation between auricular and rectal temperatures; r^2 varied

Table 3. Bias and limits of agreement (°C) between temperatures measured by several rectal thermometers in 88 clinically healthy dogs

Temperatures compared	Bias	*s*	95% limits of agreement
Mercury thermometer (3 minutes) *versus* Mercury thermometer (column stabilization)	−0.2295	0.2203	−0.2022, 0.6613
Mercury thermometer (3 minutes) *versus* Digital thermometer	0.1465	0.1999	−0.2453, 0.5385
Digital thermometer *versus* Mercury thermometer (column stabilization)	0.0829	0.2492	−0.4055, 0.5714

s — standard deviation.

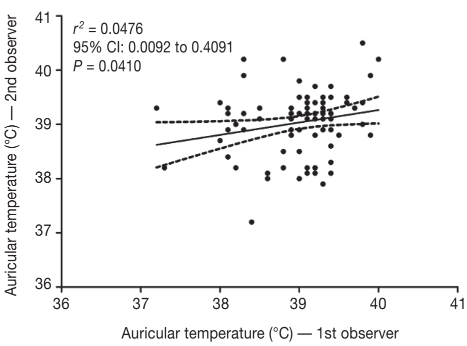

Figure 1. Correlation of auricular temperature obtained in healthy dogs ($n = 88$) by 2 independent observers. Dotted lines represent the 95% confidence intervals.

between 0.343 and 0.372 for the 3 methods of measuring rectal temperatures. The comparison between near-simultaneous duplicate auricular temperatures performed by 2 different observers resulted in a weak correlation (r^2 = 0.048), as measurements are considered more repeatable when the coefficient approaches 1.

Discussion

Rectal measurement has been the gold standard for the measurement of body temperature in veterinary practice, possibly because of the good agreement that exists between this technique and core body temperature (3,11). In children, although rectal measurement was an established method of measuring temperature, infrared thermometers are now frequently used (12,13).

The measurement of temperature at the ear has advantages over measurement at the rectum, such as the more practical anatomical location of the ear and the much faster result. However, to be clinically acceptable, both methods should agree sufficiently well to permit interchangeable use of either thermometer (4,12).

In a large systematic review of several investigations comparing ear and rectal temperatures in children (12), wide limits of agreement were found between the 2 methods, although the mean differences between temperature measurements were small. Therefore, ear thermometry was concluded to be an unreliable approximation of rectal temperature. On the contrary, auricular temperature was documented to be an accurate estimation of core temperature in dogs, although lower than temperature measured at the rectal mucosa (11). In the present investigation, Bland-Altman plots showed that the agreements between auricular and rectal temperature were greatest with glass-mercury thermometry for 3 min and least with the stabilization of the mercury column. However, the lack of a randomized sequence for obtaining temperature readings might have played a role in the results because the last temperatures obtained were more likely to be influenced by the multiple manipulations the dogs had undergone.

In hypothermic anesthetized dogs, auricular thermometry was correlated with rectal temperature (1). Nonetheless, lower correlation was obtained as animals recovered from anesthesia and body temperature increased. When Pearson's correlation was considered, our results also documented a correlation between auricular and rectal measurements. However, this analysis is not appropriate for comparing 2 methods of measurement. In this case, for example, biases indicated that auricular thermometry might unreliably overestimate rectal measurements. This poor concurrence has implications for clinical management when temperature needs to be measured accurately. Also, in cats with varying temperatures the documented limits of agreement between auricular and rectal measurements were believed to be unacceptable for clinical purposes (4). A study in dogs (5), however, documented a good agreement between these measurements sites, as supported by very small biases.

There was a weak correlation between duplicate measurements performed by 2 observers (r = 0.218), contrasting with previously published results (1), which indicated that measurements were significantly repeatable (r = 0.999). The inadequate repeatability of near-simultaneous measurements in this study could be ascribed to several factors, including multiple manipulations of the animals, excitement, activity, as well as inadequate positioning of the thermometer probe in the ear canal (4).

Although none of the dogs in the study was diagnosed with otitis externa, inflammation of the ear canal does not represent a concern when measuring auricular temperature (6).

The contrasting results of this investigation with previous studies may be partially ascribed to differences in the model of auricular thermometers. We chose an infrared auricular thermometer designed for use in humans because it is more widely available than veterinary infrared thermometers and is more common in clinical practice. Nevertheless, differences in the anatomy of the ears of dogs and humans might lead to an inadequate positioning of the thermometer probe in the dog's ear canal descending to the eardrum, thereby having the thermometer read the temperature of other parts of the external acoustic meatus instead of the tympanic membrane.

ARTICLE

Even though the statistical analysis disclosed unacceptable limits of agreement for clinical purposes, auricular thermometry may be used with discretion to avoid misinterpretation of the animal's clinical status. The results of this investigation are especially indicative that auricular and rectal temperatures readings should not be interpreted interchangeably, but rather, compared against a reference range of temperatures for that particular site. Although a few studies exist, agreement between auricular and rectal measurements is yet to be studied in a large population of hypothermic and hyperthermic dogs to better clarify the accuracy of this novel method of temperature acquisition. CVJ

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Book Review
Compte rendu de livre

Oncology for Veterinary Technicians and Nurses

Moore AS, Frimberger AE. Blackwell Publishing, Ames, Iowa, USA. 2009. ISBN: 9780-8138-2176-2. 318 pp. $83.99.

As stated in the introduction, the aim of this book is to "help achieve and promote excellence in cancer care through your professional contributions as a veterinary cancer nurse." Beginning with recognizing, diagnosing, and treating cancers, using both traditional and alternative treatments, the text flows extremely well from one topic to another. There are excellent charts, photographs, and resources and a lot of information promoting care and treatment for cancer patients.

Terminology throughout is well-explained with examples of types of cancers and visual aids accompanying each type. The book outlines the close bond between owners and the veterinary technician/nurse. The chapter focusing on euthanasia has details of the procedure before, during, and after; all are very well explained, preparing both the owner and technical team. Owners have a lot of questions at this stage of their pet's life and the book has an excellent chapter with strategies to aim in helping them.

I found this book to be of top quality both in written content and photographic materials. It is an excellent resource for both the veterinary team and owner. Each chapter ends with a "Further Reading" section which contains many resources for the veterinary team and owner as well.

I highly recommend this book to every member of the veterinary team and to make it available to owners who require guidance during this difficult time with their pet.

*Reviewed by **Claire Wolf, VT, RLAT,** Research Technician, University of Ottawa Heart Institute, Ottawa, Ontario.*