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A Comparison of Surface Infrared with Rectal Thermometry in Dogs

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Summary: Accurate determination of temperature is crucial in the diagnosis of febrile conditions. Although fewer techniques have proven as useful and reliable a predictor of core body temperature as the rectal thermometry, the process of obtaining the rectal temperature could be stressful in dogs. The infrared thermometry is a noncontact device used for measuring body temperature, with advantages which include speed, convenience, and reduced stress to the animals and reduced occupational risks to the animal handler. Therefore, there is the need to assess the consistency and agreement between non-contact infrared thermometry and traditional rectal thermometry in body temperature estimation. This study compared and assessed the sensitivity of non-contact infrared thermometer used on the forehead and nasal regions respectively with that of a rectal thermometer in dogs for body temperature estimation. One hundred and thirty (130) dogs presented for veterinary attention at the Veterinary Teaching Hospital (VTH), University of Ibadan, Nigeria were enrolled in this study during August to September 2014, irrespective of sex, age, breed or health status. Temperatures of dogs presented at the clinic were obtained using both multiple non-contact infrared thermometric measures obtained in the nasal and frontal head regions; and by rectal temperature. A multivariate cross-matrix analysis was used to assess the difference in measurements between the rectal thermometry and non-contact infrared thermometry. Descriptive statistics was used to compare variation and trend regularity of the nasal and fore-head infrared thermometry. A logistic regression of the difference in measurements was computed at 95% confidence interval and $P<0.05$. The mean difference revealed that the rectal temperature was 5.33^0C higher than the non-contact infrared forehead-based temperature and 7.57^0C higher than nasal-based temperature measurements respectively. The Bland-Altman (B-A) plot showed that the 95% limits of agreement between the frontal and nasal obtained infrared laser thermometry methods. Temperature measure obtained using non-contact infrared thermometry (forehead and nasal region of the head) was poor in consistency and agreement compared to rectal thermometry. Usefulness of non-contact forehead infrared thermometry in routine clinical practice as a close estimate of core body temperature depends on accurate calibration and therefore not recommended.

Keywords*:* Infrared thermometry, Dogs, Calibration

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INTRODUCTION

Body temperature measurement is a prime technique for assessing the health status of a patient (Blood & Studdert, 1999). Accurate determination of temperature is crucial in the diagnoses of febrile conditions (Chen Zhen *et al*., 2014). Usually, rectal temperature measurement is the traditional method of body temperature estimation in clinical veterinary practice (Radostits, 2003). Although fewer techniques have proven as useful and reliable a predictor of core body temperature as the rectal thermometry (Fortuna *et al.*, 2010), the process of obtaining the rectal temperature could induce stress in animals. It is also time-consuming and can be a potential source of cross-contamination and injury to the patient and the veterinarian (Fraden, 1991; Kunkle *et al*, 2004). Noncontact infrared laser thermometry offers advantages in Veterinary practice which include speed, convenience, decrease stress to the animal and decrease occupational risk from bites and scratches during restraint (Brunell 2012). Therefore, there is the need to assess the consistency and agreement between non-contact infrared thermometry in comparison with the traditional rectal thermometry in body temperature estimation; a measure of the veterinary applicability of the alternative technique.

This study compares the accuracy of a non-contact infrared thermometer used on the forehead and nasal regions of the head respectively with that of a rectal thermometer in dogs presented for clinical examination at the Veterinary Teaching Hospital (VTH), University of Ibadan, Nigeria.

MATERIALS AND METHODS

Animals

One hundred and thirty dogs presented for veterinary attention at the Veterinary Teaching Hospital (VTH), University of Ibadan, Nigeria were enrolled for this study. All animals sampled for the study were presented during August to September 2014 period irrespective of sex, age, breed or health status. Dog owner's consent was sought before the readings were taken.

Temperature measurement

The rectal temperature was assessed using a standardized mercury-in-glass thermometer. A BENETECH®GM300 non-contact infrared thermometer was used to obtain the forehead and nasal surface temperatures of each dog. The surface temperature readings were taken within two minutes of rectal temperature reading. Temperature measurements were obtained from the forehead at the cranial boundary of the inter-orbital space while the nasal planum was used for nasal temperature readings. Average of triplicate measurements obtained at distances of 20cm, 30cm and 50cm respectively were recorded. This was regarded as acceptable distance as Brunel (2012) reported that infrared thermometer can provide instantaneous measurement at a maximal distance of 1.5m (4ft).

Statistical Analysis

Interclass Correlation Coefficient (ICC) was used to assess the consistency between measures obtained using rectal thermometry and non-contact infrared laser thermometry. The strength of the linear relationship was determined by the correlation coefficient (R^2) of the alternative temperature method compared with rectal temperature.

Bland–Altman analysis was also used to determine agreement between the two measurement systems. Rectal temperature measurements were the standard for comparison with the results of infrared laser thermometry. An agreement limit of agreement was defined within the limits of 2 standard deviations. A linear regression was performed to test the statistical significance of any proportional bias when observed. Hence, data was analyzed for both strength of the linear relationship (correlation coefficient) of the alternative temperature method compared with rectal temperature and the agreement between them.

RESULTS

Dogs enrolled for the study was of various breeds with 67 Alsatians (51.5%) and 27 Boerboels (20.8%). Further distribution of dog according to breed include Rottweilers (10%), Caucatians (3.1%), Local (3.1%), Lhasa Apso (2.3%), Rottweiler-Alsatian cross (2.3%), Local-Alsatian cross (2.3%); while Terrier-Alsatian cross, Dobberman, Bullmastiff, Terrier, Samoyed and Preser Canari constituted 0.8% each . The average age of the dogs was 2years (between 5weeks and 8years). The mean temperature of measurements obtained using the nasal and forehead regions were 31.7±2.5 and 33.9±1.2 respectively (Table 1). The mean of rectal temperature was consistently higher (39.3±0.8). The nasal infrared temperatures and the forehead infrared readings varied from the mean rectal temperatures by 7.6±2.4 and 5.3±1.0 respectively (Figure 1 and 2).

Table 1: Correlation and one-sample t-test for noncontact infrared temperature measurements and rectal temperature readings

Temperature measure	Rectal	Forehead	Nasal
mean(^{0}C)	39.27±0.07	33.40±0.10	31.70±0.21
mean temp diff(^{0}C)		5.33±0.09	7.57±0.21
correlation		0.50*	0.26**
P-value		0.0001	0.0030

*Correlation between rectal temperature and forehead temperature. **Correlation between rectal temperature and nasal planum surface temperature

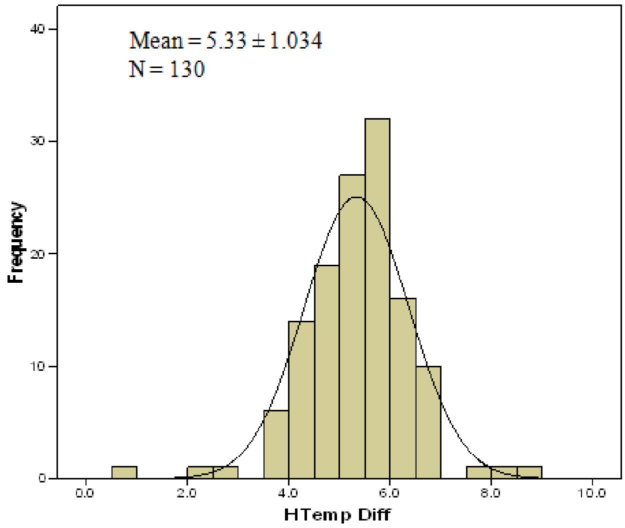

Figure 1: Frequency distribution of temperature measurements obtained using the non-contact forehead-based infrared thermometry

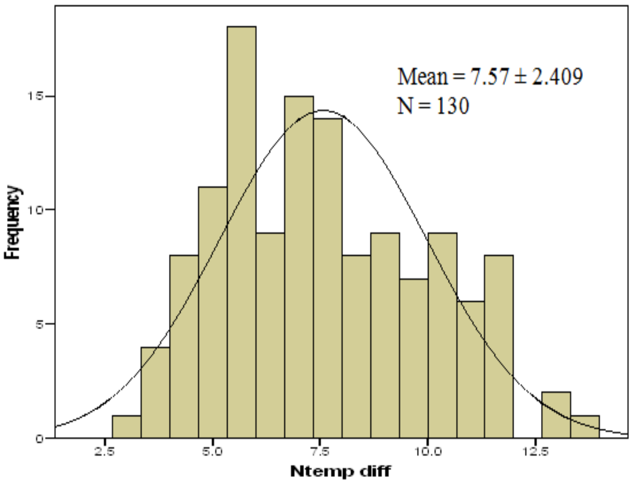

Figure 2: Frequency distribution of temperature measurements obtained using the non-contact nasal-based infrared thermometry

Table 2: Intraclass correlation between rectal temperature measurements and noncontact infrared temperature readings

	Intraclass correlation	95% Confidence Interval		F test			
		Lower bound	upper bound	Value	df1	df2	P-value
Cronbach's Alpha = 0.631	0.030	-0.16	0.13	2.71	129	129	0.0001
Cronbach's Alpha = 0.254	0.015	-0.02	0.07	1.34	129	129	0.0490

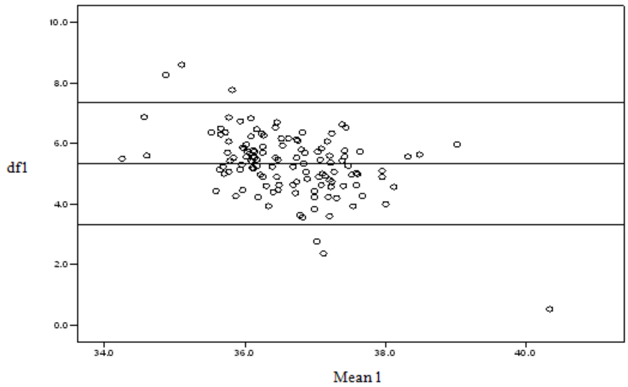

Figure 3: Bland-Altman's plot of agreement between the forehead-based non-contact infrared mean temperature and the rectal thermometry

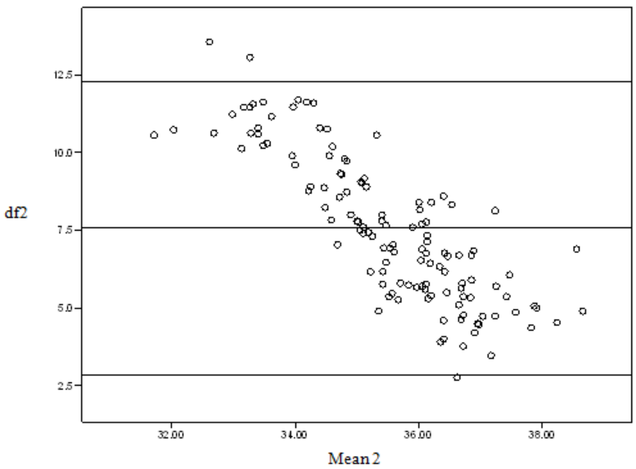

Figure 4: Bland-Altman's plot of agreement between the nasal-based non-contact infrared mean temperature and the rectal thermometry

Hence the assumption of normal distribution holds true. Therefore, a higher variability in upper and lower limits of mean temperature measures was observed using the nasal region (5.2 and 10) ^{0}C than that obtained using the forehead (4.3 and 6.4) ^{0}C. A wider margin of error from the mean rectal temperature was obtained using the nasal-based thermometry with mean temperature difference of 7.6^{0}C; as compared with the forehead-based infrared thermometry with mean temperature difference of 5.3^{0}C. Both forehead and nasal obtained thermometry were significantly different from the rectal temperature at P<0.001.

The forehead obtained thermometry significantly correlated with the rectal temperature at 0.50 (P<0.0001) as compares to the nasal-based thermometry (0.26; P=0.003). Table 2 shows that infrared forehead temperature reading is more positively correlated (ICC=0.03) than nasal planum temperature readings (ICC=0.015). There was no agreement between two noncontact infrared temperature readings and that obtained from the rectal temperature measurements. (Figure 3 and 4).

A descriptive comparison (Figure 5 a and b) shows a much regular trend with the fore-head surface temperature measurement than nasal thermometry.

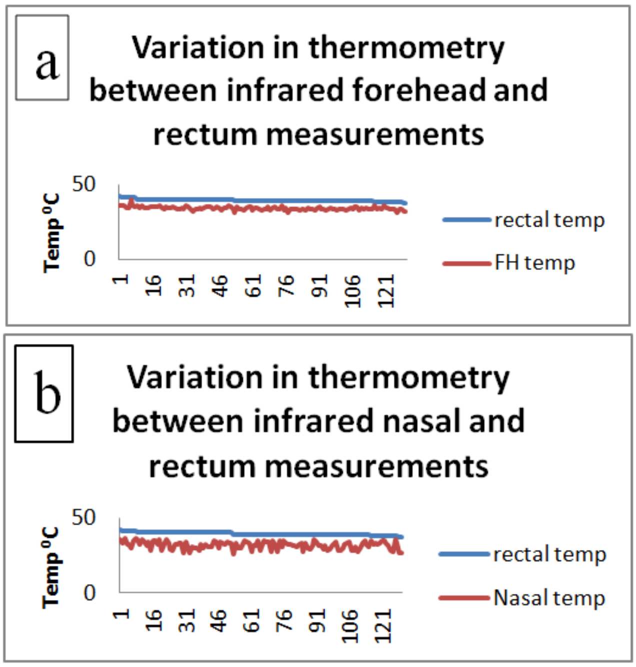

Figure 5a and b: Variability and trend components of non-contact infrared thermometry of forehead and nasal septum compared with the rectal thermometry.

DISCUSSION

Temperature difference of 7.6^{0}C using nasal planum temperature readings and 5.3^{0}C using infrared thermometry respectively in comparison to the rectal temperature readings shows that at a confidence limit of 95%, both non-contact forehead or nasal infrared thermometry was not accurately consistent with the standard rectal thermometry. This is consistent with previous report by Goodwin, 1998; Stephens, 2005; Chen and White, 2006, Shelton *et al*., 2006; Sikoski *et al*., 2007; and. Even though a study by Sousa *et al* (2012) found a satisfactory agreement between noncontact infrared and rectal temperature measurements in cats, a similar study in dogs by the same author (2011) revealed an unacceptable limit of agreement for clinical practice. Some authors have reported agreement in the use of noncontact infrared thermometry as an estimate of core body temperature in some animals (Loughmiller *et al*., 2001; Saegusa and Tabata, 2003; Shelton *et al*., 2006) however, the wide recorded error difference would prove unacceptable for clinical veterinary practice where narrow temperature measurement margin from the actual core body temperature is desired. This may lead to situation of misdiagnoses of febrile conditions based on temperature values. The wide error margin between nasal planum and forehead surface temperature may be attributed the presence of hair on the forehead which limit the ability of the beam to reach the skin surface and the fact that evaporation on the moist nasal planum of dogs may cause evaporative cooling.

A reliability coefficient of 0.631 with measurements obtained by non-contact infrared laser thermometry compared with rectal thermometry shows a moderate internal consistency. This may suggest that the forehead-based infrared thermometry may be used for estimation of core body temperature with adequate adjustments when compared to the temperature from the nasal region. However, an estimated error variance of 0.6 may indicate its unacceptability in clinical practice. A very low consistency of 0.254 was observed with nasal obtained infrared thermometry with a wider margin of error variance of 0.94.

The Bland–Altman (B-A) analysis assessed the range of agreement which is defined as mean bias which includes 2 standard deviations. The B-A plot shows that at 95% limit of agreement, the difference in temperature between the frontal and nasal surface infrared laser thermometry ranged from 3.32-7.36 (5.34±1.03)^{0}C and 2.85-12.29 (7.57±2.41)^{0}C meaning that the alternative methods do not consistently provide similar measures with degree of disagreement that includes clinically important discrepancies up to 8.6^{0}C and 13.6^{0}C with head and nasal temperature measurements respectively. This disagrees with the study of Brunel (2012) where a 2^{0}C agreement limit was observed. The implication of this variation will mean that pyrexia in animals will frequently misdiagnosed in an era where even more precise thermometry is required. A simple linear regression shows that there is a significant proportional bias obtained with the frontal (t_{129}=58.85, p<0.0001) and nasal (t_{129}=35.85, p<0.0001) thermometry respectively.

In this study, a descriptive comparison shows a much regular trend with the forehead thermometry than with nasal thermometry. A more reliable estimate could be obtained using the forehead compared to the nasal infrared thermometry. However, accuracy of the forehead thermometry could be obtained after adjusting for variation when compared to rectal thermometry.

This study shows that the nasal and forehead infrared thermometry fails to support its use as an alternative means of core body temperature estimation in comparison to conventional rectal temperature measurements in dogs. Generally, temperature measure obtained using non-contact infrared thermometry was poorly consistently, poorly reliable and did not agree with conventional rectal temperature measurements in dogs.

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