Original Article

Comparison of simultaneous measurements of tympanic membrane temperature and rectal temperature in cats

Kuan-Ting Ho[1] Shang-Lin Wang[2,3*]

Abstract

Rectal temperature (RT) is commonly used in animals to assess core body temperature. However, felines sometimes respond poorly during RT assessment. Therefore, this study compares RT and simultaneous tympanic membrane temperature (TMT) in cats. Eighty-one cats were included in the study. A digital thermometer and a human auricular infrared thermometer were used for RT and TMT measurements. RT measurement was conducted first, followed immediately by TMT measurements of the both ears. The RTs ranged from 35.9°C to 40.5°C, and the TMTs of the right and left ears ranged from 32.2°C to 39.5°C and 34.0°C to 39.5°C, respectively. The TMT of the right ear and RT were significantly correlated (Pearson $R^2 = 0.694$, $P < 0.001$). There was a significant difference between the TMT of the right ear and RT ($P < 0.001$). The mean difference of the TMT of the right ear was −0.722°C of the RT. The TMTs of both ears were significantly correlated (Pearson $R^2 = 0.935$, $P < 0.001$). There was no significant difference in the TMTs of the right and left ears ($P = 0.131$). Forty-five owners (55.56%) felt the cats were more tolerant of TMT than RT measurements. The other thirty-five owners (43.21%) felt there was no difference between the methods. Although the mean TMT was lower than RT, there was a significant correlation between TMT and RT. Veterinarians can use the TMT of either ear to predict the RT. Higher tolerance and shorter measured time may facilitate TMT measurement compared with RT measurement in cats.

Keywords: feline, rectal temperature, tolerance, tympanic membrane temperature

[1]*Department of Veterinary Medicine, School of Veterinary Medicine, National Taiwan University, Taipei, Taiwan*
[2]*Graduate Institute of Veterinary Clinical Sciences, School of Veterinary Medicine, National Taiwan University, Taipei, Taiwan*
[3]*National Taiwan University Veterinary Hospital, College of Bioresources and Agriculture, National Taiwan University, Taipei, Taiwan*
***Correspondence:** *shanglinwang@ntu.edu.tw* (S.L. Wang)
Received July 12, 2025
Accepted September 30, 2025
https://doi.org/10.56808/2985-1130.3896

Introduction

During physical examination, body temperature is one of the most important indicators of a patient's condition. The most common method of measuring body temperature in animals is using a contact thermometer against the rectal mucosa (Sousa *et al*., 2013). Obtaining core body temperature in conscious animals can be challenging but rectal temperature (RT) measurements have shown good agreement with core body temperatures (Southward *et al*., 2006; Greer *et al*., 2007). However, the presence of feces in the rectal area can impact the accuracy of temperature measurements because it may interfere with the contact between the thermometer and the rectal mucosa, thus affecting the reliability of the reading. Lesions near the rectal area can also cause discomfort and may further contribute to stress during assessments (Kunkle *et al*., 2004; Greer *et al*., 2007). Moreover, feline patients, unlike canines, often respond furiously or tensely during temperature assessments.

Tympanic membrane temperature (TMT) is the most common measurement method in humans (Craig *et al*., 2002). The rapid and non-invasive features of this method are major advantages when dealing with animals who are difficult to restrain or have a low tolerance for prolonged handling. Auricular infrared thermometers with built-in pyroelectric sensors can measure infrared radiation emanating from the tympanic membrane and provide another reading to present core body temperature (Rexroat *et al*., 1999; Long *et al*., 2011; Sousa *et al*., 2013). Some studies have investigated the correlation between TMT and RT in cats with contradictory results. Smith *et al*. (2015) and Kunkle *et al*. (2004) used veterinary infrared thermometers and obtained unreliable TMT results compared with RT results. In contrast, Sousa *et al*. (2013) used a human device and found that TMT can be a reliable alternative to RT for assessing core body temperature in cats. However, in these prior studies, TMT and RT measurements were not performed simultaneously by the same operators. Thus, the lag time between the two measurements, the sequence of measurements, and the different people conducting the measurements may have influenced the results.

This study aimed to compare the TMT and RT in cats when measured simultaneously using a human commercial auricular infrared thermometer and a digital rectal thermometer. We hypothesized that the simultaneously measured TMT and RT results did not differ and the methods can be used interchangeably for monitoring body temperature in cats. The patient's tolerance of these two measurements was also evaluated by the owners.

Materials and Methods

Animals: Cats who visited the National Taiwan University Veterinary Hospital between December 2022 and August 2024 were randomly invited to join this study. The study received an ethics review and was approved for clinical research by the Ethics Committee of the National Taiwan University Veterinary Hospital (No.: 111018). The cats who exhibited aggressiveness during temperature measurement were excluded from the study.

Temperature measurements: All measurements were consistently performed by the same people to maintain consistency and minimize potential technique variations. A digital equilibrium thermometer (MT-B117, Geon Corp., Taiwan) and a human auricular infrared thermometer (MT-30CPLB, Nissei, Taiwan) were used for RT and TMT measurements. RT measurement was conducted first, followed immediately by TMT measurements. A digital rectal thermometer was inserted a minimum of 3 cm into the rectum until an endpoint reading audible beep was heard. When measuring TMT, the cat's right ear was gently pulled toward the caudal side, aligning the vertical and horizontal canals to facilitate optimal positioning of the thermometer. The activation button of the auricular infrared thermometer was then immediately pressed when an audible beep from the digital rectal thermometer was heard. Thus, the auricular infrared thermometer reading was obtained within seconds. Next, the TMT of the left ear was measured using the same procedure. Finally, the owners were asked to evaluate the patient's tolerance of TMT and RT measurements.

Statistical analysis: Commercial software was used for statistical analysis (SPSS Statistics, ver. 21, IBM Corp., NY, USA). The TMT of the right ear and RT were compared using the Pearson correlation coefficient. The Bland-Altman method was used for comparing the divergence between the TMT of the right ear and RT. The difference between the right ear TMT and RT was analyzed using paired t-tests. The left ear results were also compared and analyzed with the results of the right ear. $P < 0.05$ was considered statistically significant.

Results

Eighty-six cats were invited to join this study. Eighty-one cats were tolerant of RT and TMT measurements, and the other five cats were too nervous to receive RT measurements and were excluded from further analysis. The RTs ranged from 35.9°C to 40.5°C (median 37.8°C, mean 38.0°C) in the remaining 81 cats. The TMTs of the right and left ears ranged from 32.2°C to 39.5°C (median 37.3°C, mean 37.2°C) and 34.0°C to 39.5°C (median 38.0°C, mean 37.3°C), respectively.

Linear regression analysis of the TMT of the right ear and RT is shown in Figure 1, and were found to be significantly correlated (Pearson $R^2 = 0.694$, $P < 0.001$). Bland-Altman analysis of the TMT of the right ear and RT is shown in Figure 2, and a significant difference was identified between the TMT of the right ear and RT ($P < 0.001$). The mean difference of the TMT of the right ear was −0.722°C of the RT.

Linear regression analysis of the right and left ear TMTs is shown in Figure 3. The TMTs of both ears were significantly correlated (Pearson $R^2 = 0.9350$, $P < 0.001$). Bland–Altman analysis of the TMT of both ears is shown in Figure 4. There was no significant difference in the TMT between the right and left ears ($P = 0.131$).

Forty-five owners (55.56%) felt their cats were more tolerant of TMT measurement than RT measurement,

and the other thirty-five owners (43.21%) felt there was no difference between these two methods. Only one owner (1.23%) felt the cats were more tolerant of RT than TMT measurements.

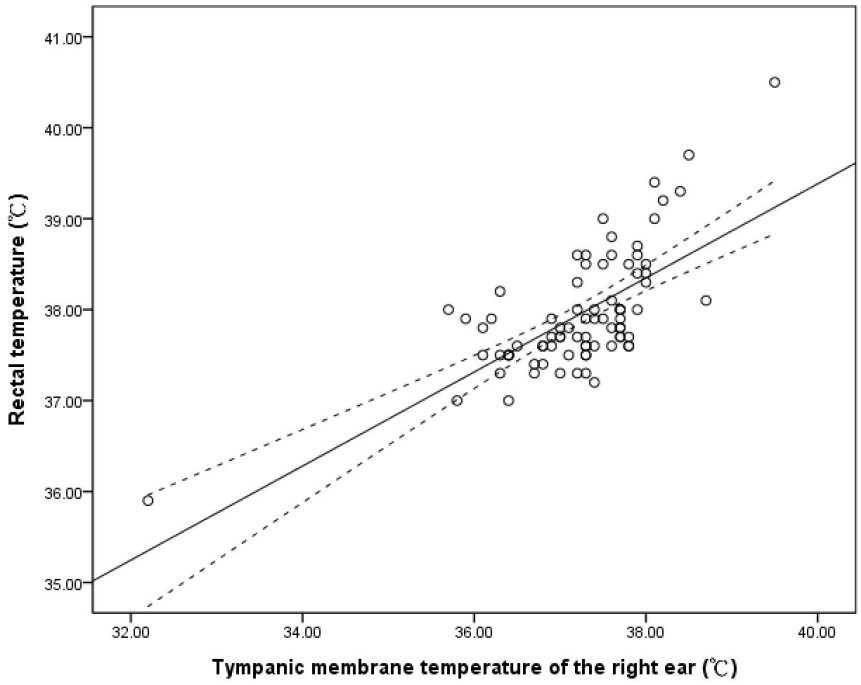

Figure 1 Linear regression analysis of the tympanic membrane temperature of the right ear and rectal temperature. The best-fit regression line and 95% confidence intervals for the regression line are shown as a solid line and dashed line, respectively. The tympanic membrane temperature of the right ear and rectal temperature were significantly correlated (Pearson R^2 = 0.694, $P < 0.001$).

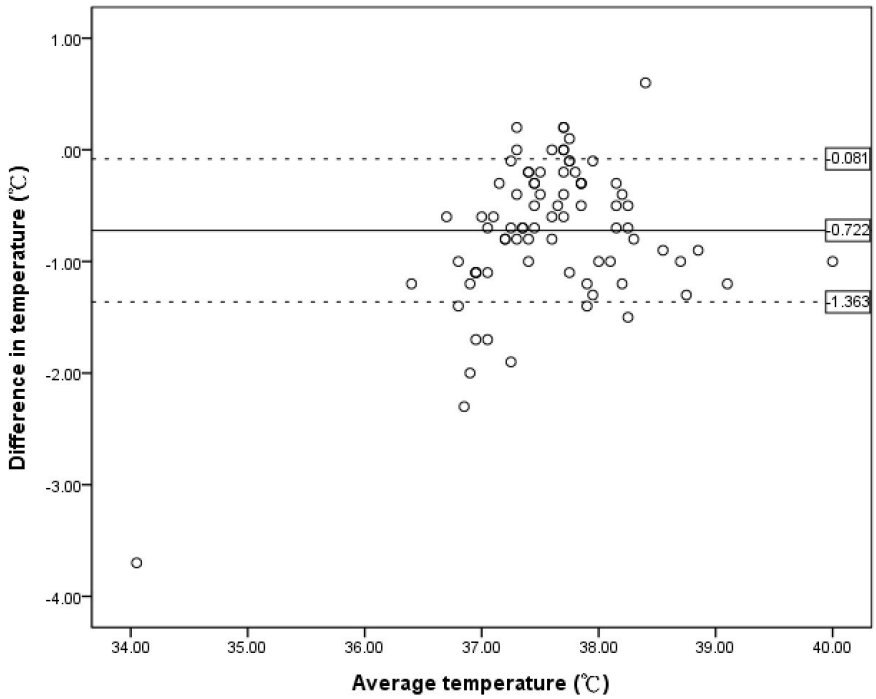

Figure 2 Bland-Altman plot of the difference compared with the average of each tympanic membrane temperature of the right ear and rectal temperature. The solid line represents the mean difference of −0.722°C between the tympanic membrane temperature of the right ear and rectal temperature. The dashed lines represent 95% limits of agreement (−1.363 to −0.081°C). There was a significant difference between the tympanic membrane temperature of the right ear and rectal temperature ($P < 0.001$).

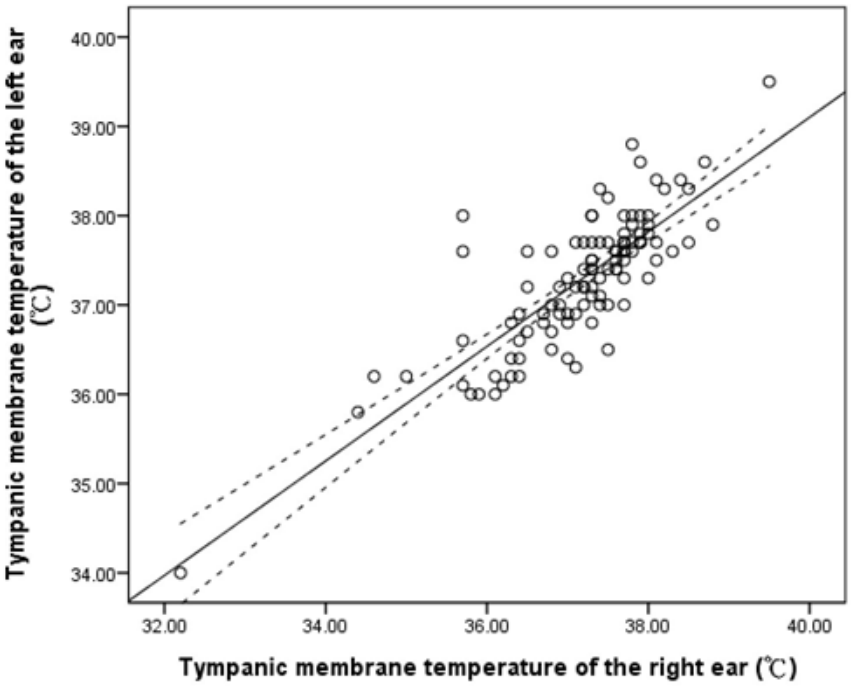

Figure 3 Bland-Altman plot of the difference compared with the average of each tympanic membrane temperature of the right ear and rectal temperature. The solid line represents the mean difference of −0.722°C between the tympanic membrane temperature of the right ear and rectal temperature. The dashed lines represent 95% limits of agreement (−1.363 to −0.081°C). There was a significant difference between the tympanic membrane temperature of the right ear and rectal temperature ($P < 0.001$).

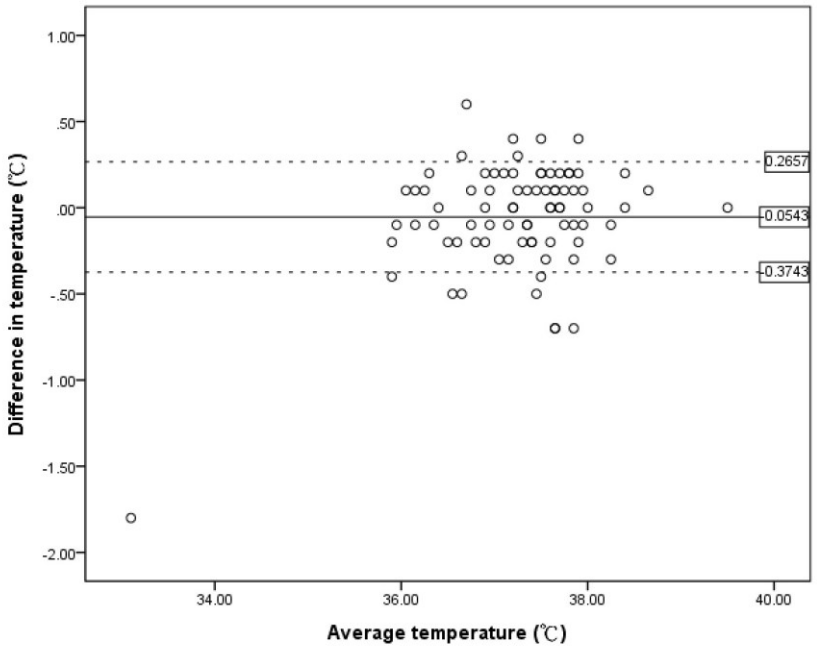

Figure 4 Bland-Altman plot of the difference compared with the average of each tympanic membrane temperature of the right ear and rectal temperature. The solid line represents the mean difference of −0.722°C between the tympanic membrane temperature of the right ear and rectal temperature. The dashed lines represent 95% limits of agreement (−1.363 to −0.081°C). There was a significant difference between the tympanic membrane temperature of the right ear and rectal temperature ($P < 0.001$).

Discussion

The TMT was significantly correlated with RT although it had a significant difference in this study. Our results revealed that the mean difference of the TMT of the right ear was −0.722°C of the RT. This trend was similar to the findings of Kunkle *et al*., Garner, and Barton *et al*., who found that TMT was lower than RT (Kunkle *et al*., 2004; Garner, 2011; Barton *et al*., 2022). However, this does not imply that the TMT measurement is inaccurate since body temperature varies by location (Kunkle *et al*., 2004). Therefore, it is

important to use the same type of thermometer consistently in each patient to monitor body temperature trends. Notably, the TMT reference range must be adjusted for each thermometer before clinical use.

The measured time gaps between TMT measurement of the right and left ears were less than 10 seconds. The TMT of the right and left ears were significantly correlated and without significant difference. Therefore, this short time gap did not influence the measured temperature results. Furthermore, both ears can be used interchangeably for TMT measurement in cats.

Only 81.2% and 93.1% of cats were tolerant of TMT measurement in two previous studies (Sousa *et al*., 2013; Smith *et al*., 2015), however, in the present study, all cats cooperated, and TMTs were successfully measured. With five cats, RT could not be obtained initially and therefore further TMT was not performed with them. We are unsure if these five cats can be measured for TMT to compare tolerance between the two methods. However, 55.56% of owners in our study felt that TMT measurement was more acceptable than RT measurement and 43.21% of owners felt that TMT measurement was equally acceptable to RT measurement. Similar results were also noted in previous studies in which feline patients showed more acceptance of TMT measurements compared to RT measurements (Sousa *et al*., 2013; Smith *et al*., 2015). Therefore, TMT can be another reliable and acceptable method to obtain feline temperature, especially in nervous cats. Besides the physical examination, veterinary patients require continuous body temperature monitoring in many situations, such as when monitoring allergic reactions during blood transfusion and rechecking infection-related fever during hospitalization. To reduce discomfort in cats, TMT can provide a less invasive means to measure their body temperature.

In this study, RT measurement usually required 10–20 seconds and TMT only required 2–3 seconds. According to these results, TMT provides a rapid, convenient, and equally reliable body temperature reading compared to RT. Thus, these findings indicate that TMT can be used as another method to obtain body temperature in cats. A strong positive correlation was identified when near-simultaneous duplicate auricular temperatures were performed and compared by two different observers in one study (Sousa *et al*., 2013). This generated consistent and reliable TMT results even when measured by different observers.

There were some limitations in this study. First, only 81 cats were included, and a larger prospective study is needed to obtain more definitive results. Second, the RT was obtained first followed by TMT measurements only a few seconds apart. This time gap may be too short for owners to differentially evaluate their patient's tolerance of the two methods. Third, ear conditions, such as inflammation, ear wax amounts, and hair in the ear canal were not recorded and analyzed, but these factors may influence TMT results.

In conclusion, although the mean TMT reading was 0.722°C lower than RT, there was a significant correlation between TMT and RT. Veterinarians can use TMT to predict RT in cats regardless of whether they use TMT in the right or left ear. Higher tolerance and shorter required measurement times may facilitate TMT measurement compared with RT measurement in feline patients.

Conflicts of interest: None of the authors has any financial or personal relationships that could inappropriately influence or bias the content of the paper.

Acknowledgments

This study was supported by grants from National Taiwan University (NTU-113L7825).

References

Barton JC, Didier MD, Silvestrini P, German AJ and Ferriani R 2022. A noninvasive method of temperature measurement using a noncontact handheld infrared thermometer fails to correlate with rectal temperature in dogs and cats. J Am Vet Med Assoc. 260: 752-757.

Craig JV, Lancaster GA, Taylor S, Williamson PR and Smyth RL 2002. Infrared ear thermometry compared with rectal thermometry in children: A systematic review. Lancet 360: 603-609.

Garner S 2011. Ear versus rectal temperature in dogs and cats. Vet Rec. 168: 248.

Greer RJ, Cohn LA, Dodam JR, Wagner-Mann CC and Mann F 2007. Comparison of three methods of temperature measurement in hypothermic, euthermic, and hyperthermic dogs. J Am Vet Med Assoc. 230: 1841-1848.

Kunkle GA, Nicklin CF and Sullivan-Tamboe DL 2004. Comparison of body temperature in cats using a veterinary infrared thermometer and a digital rectal thermometer. J Am Anim Hosp Assoc. 40: 42-46.

Long C, Pacharinsak C, Jampachaisri K, McKeon G, Howard A, Albertelli M and Felt S 2011. Comparison of rectal and tympanic core body temperature measurement in adult guyanese squirrel monkeys (*Saimiri sciureus sciureus*). J Med Primatol. 40: 135-141.

Rexroat J, Benish K and Fraden J 1999. Clinical Accuracy of Vet-Temp™ Instant Ear Thermometer: Comparative Study with Dogs and Cats. San Diego: Advances Monitors Corporation. 4 pp.

Smith VA, Lamb V and McBrearty AR 2015. Comparison of axillary, tympanic membrane and rectal temperature measurement in cats. J Feline Med Surg. 17: 1028-1034.

Sousa MG, Carareto R, Pereira-Junior VA and Aquino MC 2013. Agreement between auricular and rectal measurements of body temperature in healthy cats. J Feline Med Surg. 15: 275-279.

Southward ES, Mann F, Dodam J and Wagner-Mann CC 2006. A comparison of auricular, rectal and pulmonary artery thermometry in dogs with anesthesia-induced hypothermia. J Vet Emerg Crit Care. 16: 172-175.