# Comparison of Digital Rectal and Microchip Transponder Thermometry in Cats

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This study compares the use of traditional rectal thermometry with an implantable microchip temperature transponder in cats. The microchip transponder was implanted over the shoulder blades and was programmed with cat identification information. Concurrently, the cats were involved in a study in which they were infected experimentally with feline herpesvirus 1; this situation enabled temperature comparisons in both normal and abnormal ranges. Results from the microchip transponder technique were compared with rectal thermometry by using a concordance test of agreement. These data revealed close agreement between rectal and microchip transponder thermometry in the cat at both normal and abnormal temperature ranges.

**Abbreviation:** FHV1, feline herpesvirus 1.

Temperature measurement is part of a basic medical evaluation and is frequently necessary both in the clinical and research settings. Rectal thermometry is the most common method for obtaining a temperature in the clinical setting and is an accurate reflection of core body temperature.[7] However restraint is required for this technique, which may cause the animal to experience stress. In the research setting, repeated body temperature measurement may be required, and the handling and stress induced by this procedure may be detrimental to both the handler and animal, particularly in the case of the cat. In addition, muscular exertion affects rectal temperature,[15] thus cats may be prone to a rapid increase in rectal body temperature merely from the stress of the procedure, leading to an erroneous presumption of fever. Recent studies in other species have explored the possibility of using less-stressful methods of thermometry including implantable temperature-sensing microchips,[2-4,6,7,10,17] noncontact thermometry[2,17,19] and tympanic thermometry[2,5-8,11,13,14,16,18] and interest in the use of these alternative techniques has been increasing. A few studies have examined the use of tympanic thermometry in cats,[11,13,14] but to our knowledge, none has examined the accuracy and repeatability of implantable temperature-sensing microchips in this species. Given that some studies have reported suboptimal accuracy for microchip thermometry in a few species,[6,7,17] we considered that confirmation of its accuracy in the cat was necessary. The purpose of the present study was to compare standard rectal thermometry with the alternative method of microchip transponder thermometry in the cat.

## Materials and Methods

**Animals.** Purpose-bred domestic shorthair cats [$n = 40$ (21 intact female, 19 intact male); age, 17 wk; weight, 1.2 to 2.9 kg; $n = 40$; Liberty Laboratories, Waverly, NY] were used for this study. The study protocol was approved by the Colorado State University Institutional Animal Care and Use Committee. The cats were gang housed in groups of 8 and were cared for ac-

cording to the principles outlined in the *Guide for Care and Use of Laboratory Animals*.[9] The environment was maintained at a temperature of 18.8 to 25 °C with a 12:12-h light:dark cycle, and free-choice water and food were available at all times. The cats were socialized daily (approach, light restraint, and petting for approximately 1 min) for 2 wk before initiation of the study, and most of the cats seemed comfortable with human contact by that time.

Concurrently, these cats were enrolled in a study in which they were infected experimentally with FHV1. This study required daily thermometry and clinical assessment. Infection was performed by sedating all cats with ketamine (5 mg/kg IV) and diazepam (0.25 mg/kg IV) and inoculating both nares (25% of the inoculum in each) and the nasopharynx (50% of the inoculum) with a plaque-purified field strain of FHV1 by use of an atomizer as previously described.[12] This protocol results in infection, viral shedding, and clinical signs of FHV1, including fever greater than 39.2 °C (102.5 °F), nasal congestion and discharge, sneezing, epiphora, and conjunctivitis.

**Data collection.** On day 4 or day 5 before the study began, the cats were implanted with programmable subcutaneous microchip transponders (IPTT-300 Extended Accuracy Calibration; Bio Medic Data Systems, Seaford, DE) over the shoulder blades as instructed by the manufacturer. This procedure involved manual restraint, tenting of the skin over the shoulder blade area, quick insertion of a large-bore needle delivery device containing the microchip, and depression of the plunger on the device that expelled the microchip from the delivery device. Each transponder had been programmed with the cat's individual identification number (ear tattoo applied by the supplier). By using both methods, temperatures were obtained once during the week before infection with FHV1 and once during the week after infection when all cats had clinical signs of FHV1 infection. Thereafter daily temperatures were obtained only with the microchip transponder device. On the days when temperatures were obtained by using both methods, the cats were restrained in lateral recumbency to facilitate rectal thermometry. For both methods, temperatures were obtained in random sequence and were completed within 1 to 3 min for each animal. Signs of stress, including struggling and vocalization, and the overall approachability of each animal were noted.

**Table 1.** Summary statistics for rectal and microchip transponder thermometry

| Thermometry method | Temperature range (°C) | Temperature average (°C) | Repeatability coefficient | Range (°C) of difference between methods | 95% Agreement limits (°C) |
|---|---|---|---|---|---|
| Rectal: afebrile | 37.4–39.3 | 38.6 | 0.40 | 0–1 | −0.72 to +0.74 |
| Microchip: afebrile | 37.8–39.8 | 38.7 | 0.22 | not applicable | not applicable |
| | | | | | |
| Rectal: febrile | 38.3–41.2 | 39.5 | not done | 0–1 | −0.77 to +0.73 |
| Microchip: febrile | 38.2–41.1 | 39.5 | not done | not applicable | not applicable |

Temperatures were collected again, in duplicate, with both approaches after the cats recovered from acute infection and were clinically normal and afebrile.

Temperature measurements were obtained by using a digital rectal thermometer (Deluxe Fast Read Thermometer, Walgreens, Deerfield, IL). Its precision and accuracy were ± 0.16 °C as evaluated against a National Institute of Standards and Technology thermometer in a hot-water bath. Measurements were taken by lubricating the probe tip with a bacteriostatic lubricant and inserting it into the rectum to a depth of approximately 1.5 cm. The thermometer was held in place until a beep was heard (10 s), and the displayed temperature was recorded. The probe tip was cleaned between readings. Replicate temperatures were obtained by inserting the probe into the rectum and repeating the process twice without removing the probe.

Temperature measurements from the microchip transponders were obtained by using a compatible reader (catalog no. WRS-6007, model IPTT-300, Bio Medic Data Systems). The reader was held at a distance of 5 to 6 cm from the shoulder blade area, as instructed by the manufacturer. An audible beep (after 1 to 3 s) signaled completion of the reading, and the displayed temperature was recorded. Replicate temperatures were obtained by taking 2 readings in succession.

**Statistical analysis.** Summary statistics including temperature range and average, repeatability coefficient, range of differences, and 95% agreement limits were performed as described by Bland and Altman.[1] Data were analyzed to determine the degree of agreement between rectal thermometry and microchip transponder thermometry. This statistical method analyzes 2 continuous variables to determine whether a new technique agrees sufficiently with a standard technique to allow the new technique can replace the old. The predetermined criterion for the calculated limits of agreement (mean ± 1.96 SD) between rectal and microchip transponder thermometry in the current study was ± 0.83 °C (1.5 °F). Therefore a difference of more than 0.83 °C, on average, between thermometers would be clinically unacceptable. This determination was based on what would be considered acceptable as a difference between the 2 methodologies for the purpose of our FHV1 study. The statistical software STATA (release 10, STATA, College Station, TX) was used to generate Bland–Altman agreement statistics (the 'concord' function) in limits-of-agreement graphs ('loa' graphics option).

## Results

Among the 40 cats, implantation of the microchip was difficult due to the temperament of 7 animals, and microchips had to be reimplanted because of placement failure (typically within the first 24 h) in 4 cats. All microchips functioned appropriately for the duration of the study, displaying both identification and temperature data. On days when both methods were used, 3 staff members were required, but only 1 was necessary (no animal restraint needed) to perform daily microchip transponder thermometry during the remainder of the FHV1 study. Signs of stress (struggling, vocalization) occurred repeatedly in 26 of 40 cats during the days when multiple thermometry was performed, and each staff member was scratched at least once on these days. Struggling and vocalization were not noted on days during the FHV1 study when only microchip thermometry was performed, because restraint was not required. In addition, with the exception of rare events, no staff members were injured on these days. However, as manifested through hissing or retreat or both, 7 cats continued to resist staff members' approach, even with the microchip thermometry method.

Summary statistics including temperature range and average, repeatability coefficient, range of differences, and 95% agreement limits are reported in Table 1. The limits of agreement for microchip transponder in comparison with rectal thermometry for both the normal and febrile time periods are represented graphically in Figures 1 and 2. The agreement limit for the microchip transponder met our previously established criterion. Before FHV1 infection (when the body temperatures of the cats were normal), the repeatability of microchip thermometry (0.22) appeared to be superior to that of rectal thermometry (0.40).

## Discussion

In this study, the implantable temperature-sensing microchip was shown to agree sufficiently with rectal thermometry to accept microchip thermometry as an alternative technique for obtaining body temperature in cats. This agreement between microchip and rectal thermometry in cats was consistent with findings from similar studies in other species,[2-4,6,10] although differences among experimental protocols precluded comparison of agreement values between studies. Although core body temperature is the 'gold standard' for determination of accuracy, comparison of that measure with microchip thermometry could not be performed due to the subjects' concurrent enrollment in another study. However, a previous study[7] showed that rectal thermometry closely agrees with core body temperature. We therefore felt that comparison of microchip thermometry with rectal thermometry would sufficiently determine whether microchip thermometry was a viable alternative in cats. Repeatability of the devices in cats with abnormal body temperature was not assessed in this study, and our current findings should be interpreted with this caveat in mind.

Compared with rectal thermometry, the marked ease of use of microchip thermometry in cats during the concurrent FHV1 study dramatically decreased stress to the cats and injury to the technical staff. In addition, the ability to encode the transponders with additional information allowed easy confirmation of the identification of the research subjects. Most cats tolerated implantation of the device well. The few cases of difficult implantation were related more to the nature of the individual cat than the implantation process. Performing implantation with
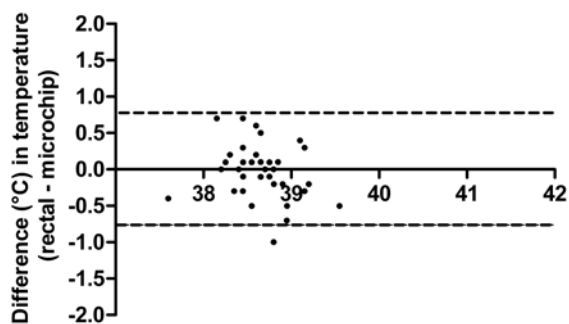
**Figure 1.** Bland–Altman plot illustrating the difference between rectal and microchip transponder thermometry at afebrile ranges. The difference in temperature methods is plotted against the pairwise mean. The horizontal reference line at 0 represents no difference between the methods. The dotted lines represent the limits of agreement (mean $\pm$ 1.96 SD).
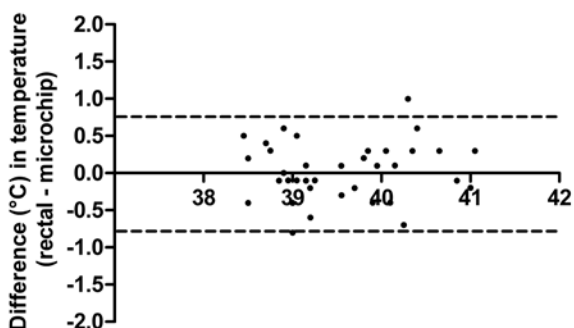


**Figure 2.** Bland–Altman plot illustrating the difference between rectal and microchip thermometry at febrile ranges. The difference in temperature methods is plotted against the pairwise mean. The horizontal reference line at 0 represents no difference between the methods. The dotted lines represent the limits of agreement (mean $\pm$ 1.96 SD).

anesthesia or sedation would alleviate this problem. Regardless, personnel felt that the difficulty of potentially performing daily rectal thermometry over the course of the month-long FHV1 study far outweighed the difficulty of microchip implantation.

In conclusion, microchip thermometry appears to be a valid and advantageous method for determining the body temperature of cats in a research setting. The microchip device and probe reader were easy to use, and staff did not require in-depth technical training to perform microchip thermometry safely and efficiently.

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