Using an Implantable Microchip for Measuring Body Temperature in Dairy Calves

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1. Introduction:

Body temperature is frequently used as a method for determining if illness is present with fever detection. Taking rectal temperature or alternatively tympanic temperature can be time consuming and requires restraint of calves. Alternatives, such as implantable microchips that can be passively read using a radio frequency identification (RFID) scanner may allow for easier monitoring of body temperature.

2. Objective:

This study aim was to validate an implantable microchip and to determine the best implant site.

3. Materials and Methods

A. Water bath validation of microchips:

Prior to implant, we validated temperature recordings between microchips (Bio-Thermo, Allflex USA Inc; Figure 2.A) in a water bath. Microchips (n=8), and an iButton temperature logger (DS1921H, Maxim Integrated; Figure 2.B), were placed in a water bath using a Latin square design. During eight hours, we recorded microchip-iButton pair temperatures. Water temperature was recorded using the rectal thermometer (GLA M700 Thermometer, GLA Agricultural Electronics; Figure 2.C) The water bath had the water temperature randomly reset within normal body temperature range (35°C – 43°C) every hour.

B. 24 hour Observational Bull-Calf Study:

Microchips were implanted in calves (n=12; 2 – 7 days of age) subQ behind the ear (EAR; Figure 1.A), subQ by the upper scapula (SCAP; Figure 1.B), and IM in the trapezius muscle of the neck (NECK; Figure 1.C) one week prior to the observational period. During the observational period, we recorded each temperature reading for the microchips for 24 hours. In order to reference temperature readings to manual temperatures, a tympanic (Vet-Temp Instant Ear Thermometer, Advanced Monitors Corporation; Figure 2.D) and rectal temperature were also taken.

Data Analysis Criteria:

All analysis were performed using SAS and R and significance was considered at ($P < 0.05$)

Accuracy

A: Regressions: coefficient of determination (R^2): high (0.71 – 0.90) and very high (0.91 - 1.0) (Figure 3)

B. Pearson's correlation (r): negligible (< 0.30), low (0.30 – 0.49), moderate (0.50 – 0.69), high (0.70 – 0.89) and very high (0.90 – 1.0) (Table 1, Table 2)

C. Bland-Altman Plot: 0 is within 95% interval of agreement (Figure 4)

Precision

High Pearson's correlation and a high coefficient of determination

Figures 1A-C: Implantation of microchips at A) EAR, B) SCAP, and C) NECK

1.A

1.B

1.C

Figures 2: Various thermometers used in the water bath validation and in the observational period

2.A Bio-thermo RFID Microchip

2.B iButton

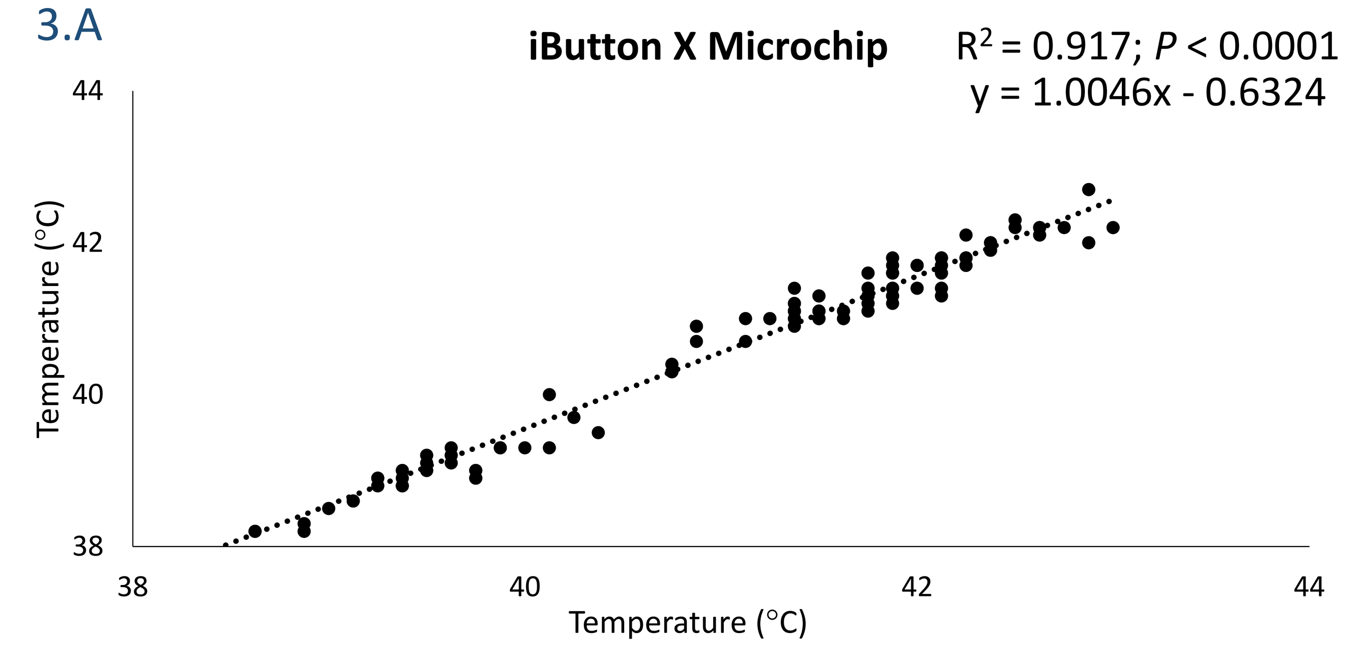
2.C GLA M700 Rectal Thermometer

2.D Vet-Temp Instant Ear Thermometer

4. Results:

Figures 3.A-B: Regressions of microchip temperature readings vs. 3.A) iButton readings and 3.B) rectal thermometer readings from the water bath

3.A



3.B

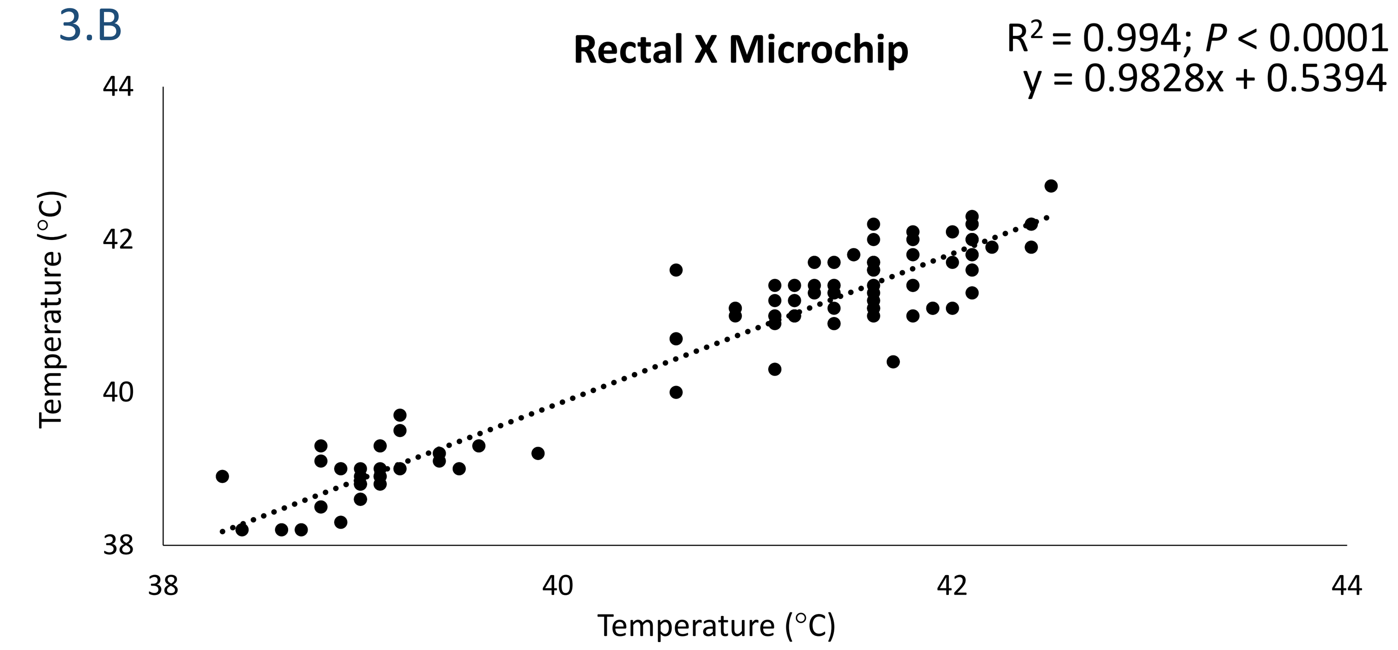
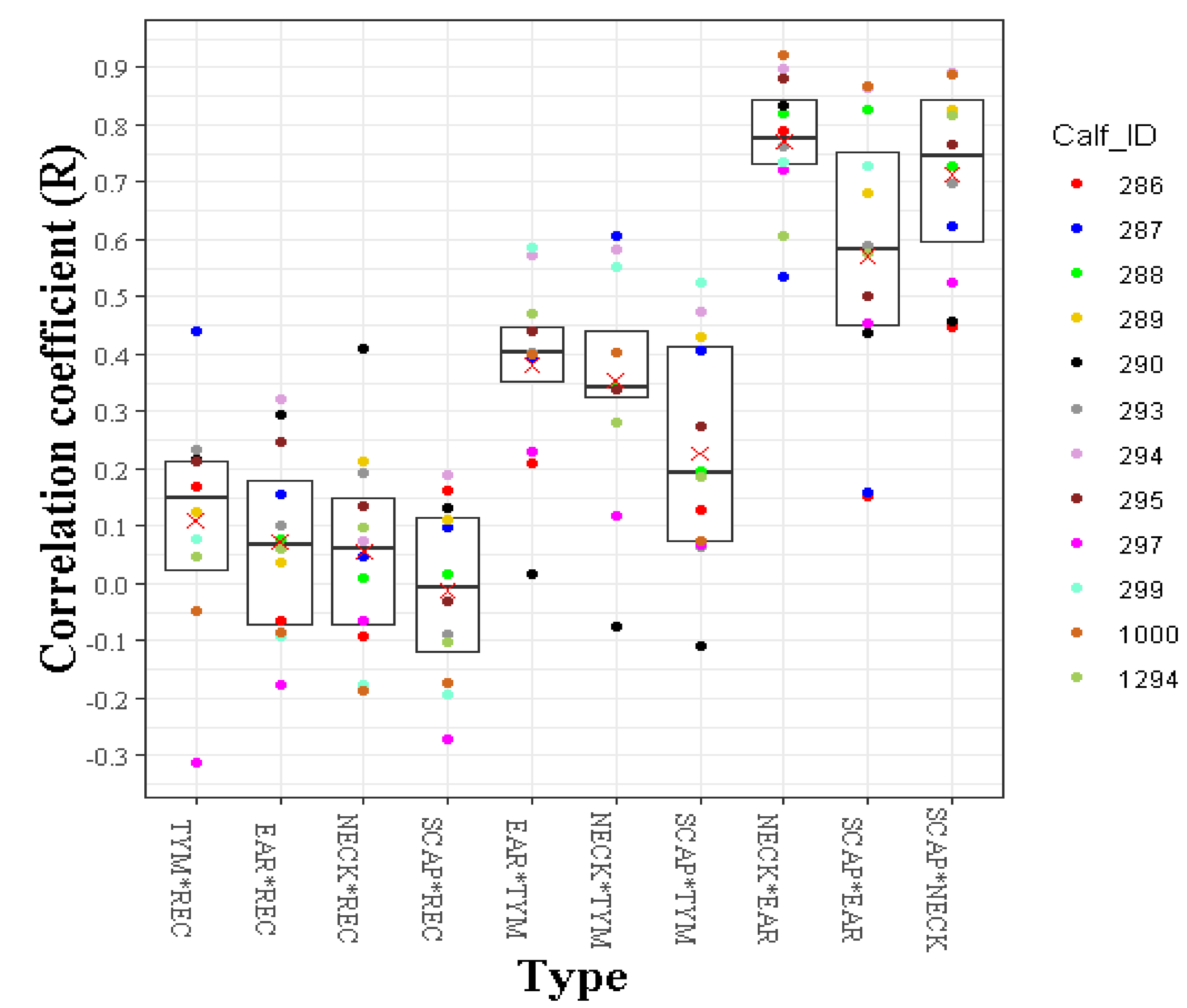


Table 1. Pearson's Correlations are reported for 5 thermometers (rectal, tympanic and , EAR, SCAP, and NECK) for each individual. An median Q1, and Q3 are reported for the thermometer correlations.

	Tympanic Rectal	EAR Rectal	SCAP Rectal	NECK Rectal	NECK EAR	SCAP EAR	SCAP NECK
Median	0.19	0.10	0.12	0.12	0.78	0.58	0.75
Q1	0.07	0.07	0.10	0.07	0.73	0.45	0.60
Q3	0.22	0.19	0.18	0.19	0.84	0.75	0.84
P-value	≤ 0.81	≤ 0.85	≤ 0.93	≤ 0.97	≤ 0.003	≤ 0.44	≤ 0.17

Figure 4. Pearson's Correlations are reported for 5 thermometers (rectal (REC), tympanic (TYMP) and , EAR, SCAP, and NECK) for each individual. A box plot shows the distribution, median and mean for each thermometer correlations.



5. Conclusion

In the lab setting (water bath), microchips were accurate and precise for temperature readings when compared to validated technologies (iButton, rectal thermometer). They were found to be with high coefficients of determination, low bias, and high Pearson's correlations. This suggests the microchips are reliable for both accuracy and precision, and repeatable.

For the 24 hour observational study when microchips were implanted in the animals, temperature readings showed individual variation, but had negligible linear relationships with rectal and tympanic temperatures.

We found high correlation between temperature readings of the microchips in the NECK and EAR. While the microchips are repeatable, precise, and accurate in a lab setting, implant location affects temperature readings.

Future research should look into how implanted microchips and rectal temperature respond to an induced fever in dairy calves. Research should also be done to determine a defined threshold for fever in calves based on a the location a microchip is reading body temperature.

6. Acknowledgements

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