

Procedure for a better heart rate and temperature loggers read out

INTRODUCTION

Heart rate and body temperature recordings are extremely important for different kinds of studies, e.g. toxicology, metabolic or thermoregulation. Being able to measure heart rate and body core temperature without human interference reduces the stress placed on the animal - circumventing any consequential fluctuations in heart rate and temperature profile. This may also result in a reduction in the number of laboratory animals required with fewer animals needed to obtain reliable data.

Telemetry loggers are quite interesting however they are expensive and involve more complex surgery. Another kind of technology is the one provide by The Star-Oddi loggers. These are small implantable recorders that measure heart rate and/or temperature with high accuracy and provide real time telemetry with live data to a PC or logging, where real-time data is stored in their internal memory, accessible after the trial. For several years the Star-Oddi loggers have been used by the food industry, the marine research field and the biomedical industry in virology, vaccinology and in studies which require accurate measurements. All data storage tags (DSTs) are delivered with calibration certificates to ensure compliance with GLP.

Over the years, most scientists implanted those loggers subcutaneously to accelerate the surgery process (less invasive). However, we suspected that subcutaneous implantation wasn't the best option for heart rate and body temperature recordings. Room temperature and non-spontaneous movement might cause some physiological artefacts measured by those loggers.

The aim of this study was to determine if subcutaneous implantation might be replaced by an intraperitoneal implantation to increase the physiological status and stability of recordings processed by the loggers.

MATERIALS & SURGICAL METHODS

This study was done on Sprague-Dawley rats weighting 300-350 grams which were housed at the vivarium of the IPS Therapeutique facility. All rats were individually housed during the experiment. The procedures performed in this study were approved by the ethical committee and in accordance with guidelines from the Canadian Council on Animal Care.

The rats were anesthetized under Isoflurane to allow the implantation of loggers. Each rat was implanted with 2 loggers; One was inserted under the skin around the scapular region; the second one was introduced into the peritoneal cavity. Each logger was programmed to record at an interval of 1-min all along the experimental phase.

Following the surgery, animals were individually housed at room temperature (28°C) and were acutely challenged at 4°C during 30-min followed by a return at 28°C during 30-min. This temperature challenge was repeated twice. This temperature was chosen based on the thermoregulation physiology. At 4°C, heart rate will increase rapidly to protect the body against hypothermia and this temperature will also activate the shivering pathway by skeletal muscles. More importantly, based on cold-induced thermogenesis, we will activate the heat production with an increase of body core temperature.

RESULTS

We first analyzed the body temperature recordings following acute cold challenge. Our data demonstrated that even during the baseline, core temperature was different. **Figure 1** shows this discrepancy between subcutaneous and intraperitoneal loggers (~1.5°C). More importantly, body temperature recordings done by loggers implanted subcutaneously were more affected by environmental temperature if we compare to intraperitoneal implantation. This result means that subcutaneous logger recorded a mix between the animal temperature and the one in the room.

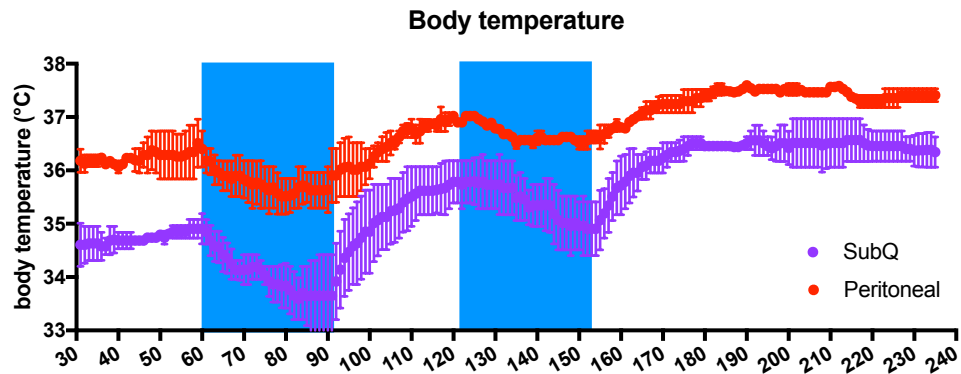


FIGURE 1. CONTINUOUS BODY TEMPERATURE MONITORING USING THE STAR-ODDI DST HR LOGGER

Star-Oddi micro DST HR logger also allows heart rate recording. Many physiological situations might involve electrical spasms in skeletal muscles such as cold environment (shivering) or physical activities (fatigue spasms). Our data indicates that intraperitoneal implantation reduced noises induced by these spasms. **Figure 2** illustrates the higher stability of heart rate recordings by the loggers implanted intraperitoneally. Also, signal quality was better as shown by the number of data points (All measurements with a Quality Index higher than 2 were excluded). Loggers implanted subcutaneously have a 45% of exclusion data points compared to only 23% for intraperitoneal loggers.

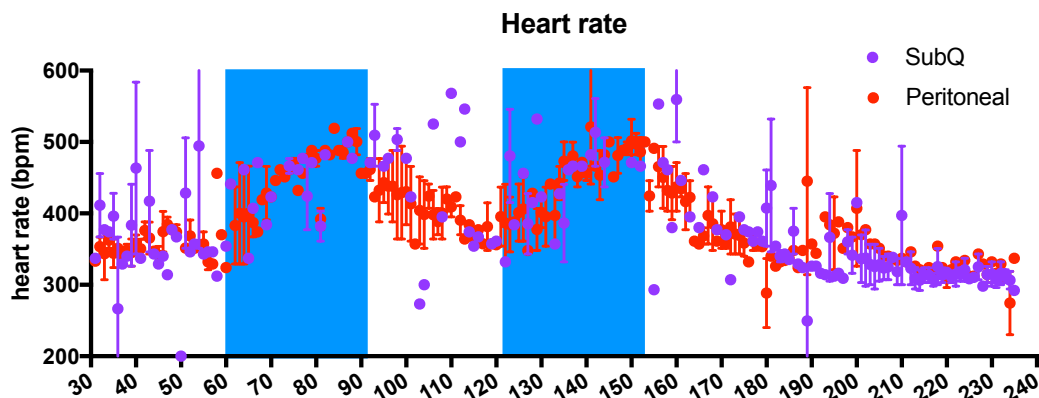


FIGURE 2. CONTINUOUS HEART RATE MONITORING USING THE STAR-ODDI DST HR LOGGER

CONCLUSION

IPS Therapeutique, in collaboration with our clients and our suppliers, is always refining equipment utilization and methodologies to improve different endpoints. This study was designed to determine which implantation methods should be used to increase signal quality however it also provided real physiological value and validation based on experimental conditions.

Based on our different results, we strongly recommend implanting loggers into the peritoneal cavity for better body temperature readouts and for better heart rate acquisitions (reducing noises induced by spasms). Our data have noted a better stability of the heart rate with a reduction of noises induced by shivering. It was demonstrated that in rats, baseline heart rate was around 350 beats per minute.

Considering this information, we can appreciate that intraperitoneal loggers gave exactly this information compared to the subcutaneous loggers which gave a more variable information for the same animals.

Moreover, body temperature recordings show a statistical difference based on the location of the loggers in the animals. The baseline core temperature in rat is around 36.5 to 37.5°C. Our data indicate that intraperitoneal loggers show a baseline temperature around 36.2°C compared to 34.6°C for the subcutaneous loggers.

In summary, we strongly suggest assessing body core temperature and heart rate with loggers implanted centrally such as the peritoneal cavity. By doing so we increase the validity and the quality of the read outs related to specific physiological conditions.