Development of a Long-Term Anesthesia Protocol for Swine

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INTRODUCTION

The use of swine as a preclinical model is becoming standard practice because of the similarity to humans in size, anatomy, physiology, and genetics. Anesthesia is frequently required for swine in research due to the nature of the procedures that are performed. Developing a protocol which considers the physiological effects of the pharmacological agents and the proper way to administer these agents is important when designing experiments. Scaling the protocols to effectively be used in pigs varying in size and disease states is also of great concern.

One area of interest in using pigs as a preclinical model is to develop non-invasive ways to test for early stages of disease. Combining magnetic resonance imaging and elastography (MRI and MRE) with molecular biomarker detection of early states of disease is the goal for researchers in many disease fields. Although using this technology could have the potential to serve as important non-invasive diagnostic tools in the future, some of the most basic parameters for anesthetizing pigs need to be determined before experiments for these studies can be run.

AIM

We aimed to develop an anesthesia protocol for MRI and MRE of swine that allows the animals to be anesthetized for multiple hours and for the administration of pharmacological and contrast agents to be done while the animal is in the MRI scanner.

METHODS

Three Minnesota mini x Yorkshire pigs (68, 40, and 30 kilograms) were anesthetized prior to and during the process of magnetic resonance imaging.

Prior to transport, the pigs must be anesthetized either by the use of gas isoflurane anesthetic or an injectable anesthetic.

Isoflurane

Pros:
- Can easily adjust dosing

Cons:
- Entire machine must be transported
- Takes more set-up time

Telazol (TKX)

Pros:
- No machine to transport
- Animal anesthetized quickly

Cons:
- Cannot easily adjust dosing

METHODS

Administration of isoflurane anesthetics can be done in one of two ways: through the use of a nose cone or a tracheal tube.

Nose Cone vs. Endotracheal Tubes

Pros:
- Less invasive

Cons:
- Can slip off nose
- If not properly fitted, isoflurane gas can leak
- Better for administration of anesthesia for a short time

Pros:
- Allows for a longer administration of isoflurane
- Does not leak

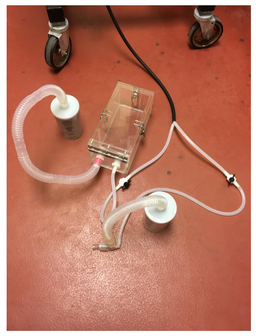
Cons:
- Invasive
- Requires personnel training
- Can injure structures in the throat

The endotracheal tube or nose cone must be connected to the isoflurane machine. There are two types of machines commonly used in animal medicine:

Rebreathing vs. Non-Rebreathing Machine

Pros:
- Circular flow of gas – the exhaled gas and oxygen are recycled back into the animal which uses less isoflurane
- Used for animals over 10lbs

Cons:
- Expensive
- Large



Pros:
- Smaller and simpler
- Cheaper

Cons:
- Isoflurane and oxygen are not recycled
- Used only on animals under 10lbs

METHODS

Once the pig is anesthetized, it is necessary for proper monitoring to occur.

Vitals are monitored by the use of a pulse oximeter and an anal thermometer.

The following physiological symptoms should determine the amount of isoflurane anesthesia that is administered to the animal:

- Muscle tension/tone
  - if muscle tone is great, more anesthesia may need to be administered
- Eye position/pupil dilation
  - Under proper anesthesia, eye position should be rotated back and pupil should be normal to slightly dilated
- Breathing
  - Breathing should be within normal rates or slightly slowed if under proper anesthesia
- Reflexes/the toe pinch test
  - Most reflexes should be diminished when properly anesthetized

Normal vitals of swine under proper procedural anesthesia are as follows:

	Temperature	Heart Rate	Respirations
Young	102 - 104 °F	100 – 103 beats/min	8 – 18 breaths/min
Adult	100 – 102 °F	60 – 90 beats/min	8 – 18 breaths/min

Depth of anesthesia progresses in a series of stages. Some of the stages may be bypassed with the use of another form of anesthesia, such as an injectable.

METHODS

Stage 1: Voluntary Excitement

- Animal is unconscious and may exhibit fight or flight reactions and disorientation
- This stage can be bypassed with injectable anesthetics

Stage 2: Involuntary Excitement

- Beginning of loss of consciousness; animal may become excited and have an increased heart rate
- This stage can be bypassed with injectable anesthetics

Stage 3: Surgical Anesthesia

- Plane 1: light anesthesia sufficient for minor-noninvasive procedures; normal heart rate and diminished reflexes
- Plane 2: sufficient for most surgical procedures; heart rate and respirations are normal but may increase with surgical stimulation
- Plane 3: deep anesthesia; shallow respiration and low heart rate; no response to surgical stimulation
- Plane 4: overdose of anesthesia; severe cardiopulmonary depression occurs; animal loss is eminent

CONCLUSIONS

Intubation under TKX anesthesia prior to transport minimized the personnel and MRI/MRE reservation time needed and, thus, saved money.

Intubating the pig for isoflurane anesthesia provided the most efficacious way to manipulate dosing of the anesthetic based on vital signs for long period of time and was more secure than the nose cone.

The standard dosing of TKX at 1mL/23kg administered via intramuscular injection provided a proper anesthetized state for short transport (0.2 miles) and later isoflurane administration.

We also found that the animals could not tolerate TKX post-isoflurane anesthesia, which should be taken into consideration if isoflurane anesthesia cannot be continued during transport.

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