**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 an important non-invasive diagnostic tool 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.

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

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

**Rebreathing vs. Non-Rebreathing Machine**

**Pros:**
- Allows for a longer administration of isoflurane
- Does not leak
- Invasive
- Requires personnel training
- Can injure structures in the throat

**Cons:**
- Not heated
- Respirations will be within normal rates or slightly slowed if under proper anesthesia
- Reflexes/teeth pinch test
- Most reflexes should be diminished when properly anesthetized

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/teeth pinch test**
  - Most reflexes should be diminished when properly anesthetized

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

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Heart Rate</th>
<th>Respiration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Young</td>
<td>102 - 104°F</td>
<td>100 – 103 beats/min</td>
</tr>
<tr>
<td>Adult</td>
<td>100 – 102°F</td>
<td>60 – 90 beats/min</td>
</tr>
</tbody>
</table>

**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.

**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 respirations 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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