Surgical Models and Perioperative Care in Swine

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Estimated average growth rates

Sinclair  Yucatan  Gottingen

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Selection of anesthetic protocols for swine

- Match the anesthesia to the type of surgery
- Consider the goals of the scientific protocol
- Make the selection based upon physiologic effects of the anesthetic
- Minimize the number of agents utilized to minimize the physiologic variables
- Use isoflurane or sevoflurane as a default agent (Discontinue other inhalants)

Injectable anesthetic protocols

- The physiologic effects of injectable agents are changed when multiple agents are used in the same protocol
- The physiologic effects of the protocols may vary widely between species
- If physiologic measurements are made under the protocol, the physiologic effects must be considered in advance
- Injectable protocols should be continuously infused rather than given as repeated bolus injections
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This methodology does not require more than one person.

Intubation
Anesthesia

- Tiletamine/Zolazepam, especially if combined with other anesthetics, should only be used in physiologically normal pigs and never in pigs in which cardiovascular or other systemic defects are being created.


Telazol/Xylazine or Telazol/Ketamine/Xylazine

- Contraindicated in protocols with cardiovascular, CNS or renal compromise.
- There is not any problem with using the combination for chemical restraint if no physiologic measurements are being made.
- Very useful for large animals because of small volume injections.

Pain assessment

Involves the following observations:
- Condition of incision
- Attitude/Behavior
- Temperature/Pulse/Respiration
- Feces
- Urine
- Appetite
- Water consumption
- Pain score
Preemptive analgesia

- Local Anesthetic Infusion
- Epidural
- Systemic Opioid or NSAID

Fentanyl patches

- Highly variable - breed, age, site, moisture, heat, type of procedure
- Yucatan - 17-22 kg, 100 µg/hr, peak 42-48 hours
- Farm Breeds - 17-25 kg, 25-50 µg/hr
- Require monitoring
- NMDA receptor agonist, windup, postinjury facilitation
- Overdosage may occur
- Approximately 5 µg/kg/hr
- Buprenorphine patches may be better

Aseptic technique

- Antibiotics are not a substitute for aseptic technique and the use of iodine impregnated adhesive drapes as a final prep is highly recommended
- Catheter and device implantation should be scrupulously aseptic. Remove the device if it becomes infected
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Wound protector (Vi-Drape, MCD)

Humane restraint

Yucatan 22 Kg Female

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Cardiac conduction system

- Neurogenic rather than myogenic
- Large numbers of adrenergic and cholinergic nerve fibers
- Nerve fibers in AV node and bundle branches
- More proximal bifurcation of bundle branches, more connective tissue, less elastic tissue
- Large well differentiated sub-endocardial Purkinje cells
- Blood supply to conduction system similar

Weight vs. age matching

Weight
- Different between breeds at same age
- Index hemodynamics to body surface area

Age
- Differences in hemodynamics at various stages of maturity even within the same breed
- Heart weight: Body weight decreases with maturity
Atherosclerosis

- High cholesterol / High fat diets
- Endothelial / Intimal damage
- Fatty streak lesion
- Macrophage foam cells
- Fibrous plaques (collagen, elastin)
- Complicated lesions - inflammation, necrosis, calcification, neovascularization, hemorrhage

Coronary artery restenosis

- Stent implantation
- 2-6 weeks for lesion
- Occlusion may lead to infarction and aneurysm

VSD closure
Induced models

- Neonatal shunts - PDA, ASD, VSD
- Aortopulmonary shunts
- Coarctation of the aorta
- Aneurysm models
- Pressure & volume overload models
- Myocardial infarct/coronary artery
- Valvular replacement
- Growing heart model

Lateral thoracotomy 4\textsuperscript{th}-5\textsuperscript{th} intercostal space

Median Sternotomy

Manubrium Intact

Manubrium Split
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Ventricular hypertrophy

Concentric
- ↑ Left ventricular wall thickness
- ↑ Systemic blood pressure
- Pressure overload models induced by surgical banding

Eccentric
- ↑ Left ventricular end diastolic diameter
- ↑ Cardiac output
- Volume overload models induced by arteriovenous fistulas or valvular regurgitation

Pressure overload models

Pressure overload models induced by surgical banding

INFARCT
Clip/Ligature
Atherosclerosis
Ameroid constrictor
Angioplasty balloon
Microspheres
Stent
Pulmonary system

- Lung Lobes (7): Shock organ in pig
  - Left: cranial, middle, caudal
  - Right: cranial, middle, caudal, accessory
  - Mediastinum: thin and friable
  - Alveoli easily ruptured (emphysematous bullae)
- Models:
  - ARDS: Pulmonary Intravascular Macrophages
  - Nitric oxide therapy
  - Asthma
  - Oxidative stress
  - Cystic Fibrosis:
    - CFTR

Ventral View of Abdomen

Abdominal Viscera

Right Kidney
Left Kidney

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Renal diseases
- Vesicoureteral reflux
- Intrarenal reflux
- Hypertension
- Hydronephrosis
Suture selection

- Avoid the use of inflammatory suture materials such as surgical gut, silk or absorbable materials containing antimicrobials
- Skin incisions should be closed using a subcuticular pattern with absorbable suture and never staples
- The incision should be sealed with tissue glue
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Summary of porcine surgical models

- General surgery, organ transplantation, interventional catheters
- Cardiovascular - myocardial infarction, atherosclerosis, arrhythmia ablation, heart failure
- Gastrointestinal/Digestive - oral studies, motility & emptying time different, first pass metabolism
- Renal - hydronephrosis, intrarenal surgery
- Dermal - transdermal absorption, wound healing, reconstructive surgery
- Hepatic - catheterization for drug studies, parenchymal ablation
- Laparoscopic and natural orifice transluminal endoscopic surgery (NOTES)
- Other surgical models - neurosurgery, ophthalmic, orthopedic, fetal, pulmonary, oral and maxillofacial

Postoperative Care of Swine

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Postoperative care of swine begins preoperatively

Planning & preparation
• Training
• Support equipment
• Analgesic plan
  – Preoperative
  – Intraoperative
  – Postoperative
• Schedule follow-up diagnostics

Preoperative training
• Begin training pre-op
  – 1-8 weeks based on:
    • Complexity of task(s)
    • Age & personality of pig(s)
• Training for:
  – Chronic drug administration
    • Preferred foods, treats, liquids for giving oral medications
  – Examinations
    • Standing on tables or walking up ramps
    • May require months of daily training in long-term studies

Recovery unit
For up to 24 hours post-op, recommend:
• Adjustable lighting
• Small holding pen
• Padded surface/bedding
• Absorbent pads
• Circulating warm water heating blanket
• Heat lamp
• IV fluid hanger
Postoperative support equipment

- Humidified oxygen
- Stethoscope
- Laryngoscope
- Thermometer, lubricant
- Pulse oximeter
- Bandage scissors
- Adhesive tape
- Personal protective equipment (PPE)
- Stocked crash cart
- Monitoring sheets

Postoperative nursing care

- Physiological Support
  - External warming
    - Heat lamp, circulating water blanket
  - Absorbent pads, blankets
  - Good footing
- Monitoring
  - Frequent, repeated measures
  - Temperature, pulse, respiration
  - \(O_2\) saturation, blood pressure

Postoperative housing

- Size appropriate for allowable postoperative activity
  - Good footing to prevent:
    - Falls
    - Damage to incision or skin
  - Gradually increase size for major body cavity & orthopedic surgeries
  - Easy to access & easy to clean
Postoperative pain control

• Pharmaceutical
  – Analgesics
    • Oral
    • Transdermal
    • Injectable
• Non-pharmaceutical
  – Good footing
  – Soft bedding
  – Pen size not too large
  – Bandages as appropriate

Incision monitoring

Immediate post-op

3 days post-op

2 weeks post-op

Postoperative follow-up

Common follow-up:
• Suture removal
• Treatments
  – Analgesics
  – Research meds
• Imaging
  – Radiographs
  – Fluoroscopy
General reference textbooks for swine


Websites

1. Contains swine literature database from Animal Welfare Information Center
2. Contains reviews of models and Sinclair, Hanford and Yucatan information
   http://www.sinclairresearch.com/
3. Tutorial on swine procedures in research: Laboratory Animal Training Association
   http://www.latanet.com/online/onlinetr.htm
4. Göttingen minipig background information
   http://minipigs.dk
5. CD Rom training series on Husbandry, Handling, Injection Techniques, Anesthesia, Analgesia and Perioperative Care
   http://www.latanet.com/desktop/drs.html
   http://www.latanet.com
6. National Swine Research Resource Center
   http://www.nsrrc.missouri.edu/