Principles of Rodent Aseptic Surgery & Perioperative Care

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Cardinal signs of inflammation

- Rubor – Redness
- Calor – Warmth
- Tumor – Swelling
- Dolor – Pain
- Functio laesa - Loss of function

What’s wrong with this suture?

Tissue healing basics

- Factors affecting the healing process
  - Animal (age, immunity, disease, nutrition...)
  - Surgical site

In theory, there is no difference between theory and practice... But in practice there is

--- Yogi Berra ---

Be careful with Dr. Google

Not everything you see in practice in the internet is in accordance with the fine principles of surgery in rodents

Time = Trauma

Resources

Don't forget your #1 resource: Your Veterinarian
Surgical area setup

This?

or

This?

Surgery location
≠
Animal prep area

Recovery

Heat pad under ½ of cage allows rodent to escape excess heat

Crowded surgical area setup

Suture in non-sterile field due to overcrowding

Organized surgical area setup

Magnification

Headband surgical loupes

Magnification loupes on glasses
Surgical aid equipment

- Stand alone stereomicroscope
- Ceiling mounted stereomicroscope

Magnification

- 1X (100%)
- 2X (200%)

Lighting

- Inexpensive battery-operated LED lights with head bands may be purchased (e.g., Lowe's), but may lack light adjustment capability

Instrument selection

- Scalpel handle #3
- Needle driver vs. hemostat

Fulcrum
Instrument tip selection

- Sharp/sharp
- Sharp/blunt
- Blunt/blunt

Micro-surgical instrument selection

Needle driver

- Longer instruments allow handles to rest on hands between thumb and index (web of the hand) for greater control.
- Rounded handles (vs. flat) allow rotation around the axis for greater control.

Instrument cleaning & lubrication

Cleaning steps:
1. Soak in enzymatic solution (ultrasound if available)
2. Brush/clean
3. Rinse
4. Lubricate & dry on

Instrument sterilization

- Moist heat (autoclave)
- Cold (chemical)
- Ionizing radiation
- Ethylene oxide
- Hot (glass) bead sterilizer

Sterilization Indicators

- Bacillus stearothermophilus spore test
- Steam chemical indicator
- No estéril
- Estéril
- Autoclave tape
Sterile Gloving

http://vpr.utsa.edu/files/larc/DonningSterileSurgicalGloves.mov

Surgeon’s prep

Instrument handling & hand positioning

Proper instrument grip

Improper instrument holding
Pencil grip technique for holding thumb forceps

Holding hemostats or scissors: Thumb & Ring finger – Index finger directing instrument

Holding the needle driver: Thumb & Ring finger
Palmning the needle driver
Note the comfortable, well-supported & rested position of the hands.

Unsupported hands tremble more.

Needle & suture material

Needle anatomy

Tissue Drag

Swaged Needle  Eye Needle

Swaged Needle  Eye Needle

<table>
<thead>
<tr>
<th>NEEDLE TYPE</th>
<th>DESCRIPTION</th>
<th>USES</th>
<th>NEEDLE POINT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cutting</td>
<td>Triangular point with cutting edge on inner curvature of the needle</td>
<td>• General skin closure • Subcutaneous tissue</td>
<td>△</td>
</tr>
<tr>
<td>Reverse Cutting</td>
<td>Triangular point with cutting edge on outer curvature of the needle</td>
<td>• Skin closure • Retention sutures • Subcutaneous tissue • Subcuticular layer • Ligamentous tissue • Fibrous tissue</td>
<td>△</td>
</tr>
<tr>
<td>Taper Cutting</td>
<td>Round bodied needle with a honed reversed cutting point</td>
<td>• Where a strong penetrating point is required</td>
<td>△</td>
</tr>
<tr>
<td>Taper</td>
<td>Round shaft, tapered point, no cutting edge</td>
<td>Soft tissue such as • Gastrointestinal tract • Fascia • Vascular &amp; • Most other soft tissues</td>
<td>○</td>
</tr>
</tbody>
</table>

Absorbable vs. non-absorbable

Suture materials
- Degradation properties
- Structural properties
- Size and tensile strength
- Packaging
Multi stranded (braided) Suture

Single stranded (monofilament) Suture

Suture Refinement (antibacterial-coated) Suture Plus

Knot security

Simple Interrupted Closure

Skin SC

Simple Continuous Suture Pattern

Simple Interrupted Suture Pattern

Closure

Wound clips

Tissue adhesives cyanoacrylate

Note: Skin tissue eversion is OK, inversion IS NOT

Clips, applier & remover
Dead space = bacteria’s dining room

Close dead space

Surgical patient preparation

Surgical planning optimizes success…
- Asepsis
- Infection risk
- Surgeon
- Assistant(s)
- Pre-, intra- & post-op care

Acclimation

The Wonders of Acclimation

The healthy rodent
Aseptic technique & infection control

Infection risk

Antibiotic Use
- Antibiotics may make a 3rd rate surgeon into a 2nd rate surgeon, but they will never make a 1st rate surgeon out of a 2nd rate surgeon
  ---Vince Mendenhall---
- Not a substitute for proper asepsis (…false sense of security…)
- Use judiciously – resistant strains
- Consider antibiotic rotation (↓ resistant strains)
- Generally not recommended - justify
- Best preemptively
- Once pre op usually enough
- Source of variables???

Assessing antibiotic need
- Immune deficiency
- Certain hollow organs
- Extensive tissue dissection
- Extensive blood loss
- Inadvertent contamination
- Devices & biomaterials
- Lengthy procedure
- Stressed, aged and ill
- Inexperienced surgeon (poor training & Hx of infections)
  - If experience = ↓ antibiotic

Pre-op prep

Remember ophthalmic ointment to avoid corneal injury
Apply as soon as anesthetized

Pre-op prep

Clipping is superior to chemical depilation
Chemical depilation (e.g., Nair) – irritating – leave on skin 45-60 sec – wipe off
**Myth:** Rodents don't get infections

**Fact:** they get infections like any other animal

POVIDONE IODINE or CHLORHEXIDINE?

- **POVIDONE IODINE**
  - Misses important wound pathogens (e.g., *Pseudomonas, Acinetobacter*)
  - Reduced activity in presence of organic matter

- **CHLORHEXIDINE**
  - Presence of blood does not interfere with activity
  - My choice

**≥3X**

**Scrubbing steps**

1. Remove hair
2. Apply 70% alcohol to degrease area
3. Apply chlorhexidine scrub/soap (NOT solution) from center to periphery
4. Apply 70% alcohol from center to periphery
5. Repeat steps 3 & 4 two more times (or more)
6. After last alcohol apply chlorhexidine solution (NOT scrub)
7. Allow to dry - Killing bacteria occurs by combination of both chemical & dessicating actions

**Draping**
Draping

Grocery item needs to be validated (tested) at your institution

Draping with Press’n Seal

Don’t forget the tail
Important thermoregulatory organ

Draping The Stereotax

Tegaderm

Draping The Stereotax & Other Equipment
Draping equipment parts (microscope, stereotax, vaporizer, etc.) that come in contact with sterile gloves during surgery prevents cross-contamination.

Securing the Illusive Mask
Tie behind upper incisors
• prevents mask from dislodging
• prevents gas leakage


Incision
Lateral tension during incision results in precise incision
Jagged edges result from:
1. Inadequate lateral tension
2. Back & forth cutting technique (vs. confident one time stroke)

Tissue protection
“Wet tissues = Happy tissues”

Take time to expose & isolate the operative area

A couple of minutes of patience will save many minutes of aggravation

Exposure
Bleeding control

- Prevention is best – Take care of even small bleeders
- Employ blunt tissue dissection where possible

Gelfoam

- Hemostatic, sterile, water-insoluble prepared from purified pork skin
- Absorbs & holds many times its weight of blood and other fluids
- Comes as sterile sponges or Q-tip like ‘Spears’

Hot bead sterilizer for bleeding control

Results in minimal tissue necrosis compared to cautery

Overzealous cautery use
Proper closure
Avoid over tightening skin and muscle layers
- Skin cut to cut surface apposition = 👍
- Dermis to dermis apposition = 👍
- Epidermis to epidermis apposition = 👎
- Epidermis to dermis apposition = 👎

Proper Apposition  Improper Apposition

Monitoring, thermoregulation, recovery & fluid maintenance

Normal Temperature

<table>
<thead>
<tr>
<th></th>
<th>°F</th>
<th>°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOUSE</td>
<td>99</td>
<td>37</td>
</tr>
<tr>
<td>RAT</td>
<td>99.5</td>
<td>37.5</td>
</tr>
</tbody>
</table>

Anesthetics & Hypothermia
- All anesthetics depress thermoregulation
- Vasodilation

Fear Hypothermia

- Rodents lose heat rapidly (high surface area/body wt ratio)
- Cycle starts at induction – anesthesia depresses temp control centers
- Exacerbated by cold, dry gases, shaving, prep solutions & admin of cold fluids
- May be difference bet life & death, reliable & unreliable data, success & failure
Fear Hypothermia

- Prolongs recovery
- ↑ potency of volatile anesthetics
- Leads to hypoventilation
- ↓ platelet function
- Bradycardia, fatal arrhythmias, myocardial infarction
- ↑ blood viscosity = ↓ gas exchange

Fear Hypothermia

- ↑ stress response to surgery
- ↑ risk of infection
- Impaired wound healing
- CNS depression
- Interferes with drug metabolism
- Special concern with hairless strains and neonates

Preventing Hypothermia

- Monitor temp
- Cutaneous warming (lamps, heating blanket) — thermometer next to animal prevents burning (≤40 °C, 104 °F if using heat lamp)
- Preheat prep (scrub) solutions
- Airway heating
- Administer pre-warmed fluids

Prevention... start ASAP

- Homeothermic blanket (self regulating)
- Circulating water blanket: safe, uniform warming
- Electric blanket: focused warming areas, elements may burn
- Heat lamp: difficult to judge distance (burns), some institutions have banned it

Heat pad under induction & recovery cage
- Heat blanket (green) under induction chamber
- Insulate with bubble wrap, Press’n Seal or Saran wrap

Press’n Seal

Bubble wrap
**Homeothermic (self-regulating) Pad**

- [www.ezanesthesia.com](http://www.ezanesthesia.com)
- [Physiosuite kentscientific.com](http://www.kentscientific.com)

**Don’t forget the tail**
Important thermoregulatory organ

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**Hydration**

<table>
<thead>
<tr>
<th></th>
<th>Blood Volume (ml)</th>
<th>10% Blood Loss (ml)</th>
<th>20% Blood Loss – shock risk (ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mouse (20 grams)</td>
<td>1.5</td>
<td>0.15</td>
<td>0.3</td>
</tr>
<tr>
<td>Rat (200 grams)</td>
<td>15</td>
<td>1.5</td>
<td>3</td>
</tr>
</tbody>
</table>

- Like hypothermia, good hydration may be difference bet life/death, success/failure
- Thus importance of meticulous bleeding control

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**The Value of \(O_2\)**

- Supplement when possible, even during anesthesia recovery
- The value of gas anesthesia in a vaporizer – concurrent administration of \(O_2\)
- Use anesthesia system w/o anesthetic to supplement \(O_2\) when using injectable anesthetics

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**Pharmacological Pain Control**

- Best when administered before insult (a.k.a. preemptive analgesia)
- Multimodal superior to single agent

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- Make a habit to administer WARMED fluids before surgery – Lactated Ringer’s solution or Normal saline
  - Mice 0.5-1 ml SC/IP
  - Rats 5-10 ml SC/IP
Local Anesthesia
- Can reduce required dose of analgesics
- Prevents hyperalgesia (amplification of pain signal)
- 1% lidocaine/0.25% bupivacaine (50/50 mix by volume)
- Incision site and underlying tissues
- May need to dilute, esp. for mice – dilution reduces duration of effect (Grant et al, 2000, J.Pharm and Tox Methods, 43, 69-72)
- Epinephrine prolongs action

Local Anesthesia – Part of Multimodal Mix

<table>
<thead>
<tr>
<th>Local Anesthetic</th>
<th>Onset</th>
<th>Duration</th>
<th>Do not exceed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lidocaine (xylocaine)</td>
<td>1-3 min</td>
<td>~40 min</td>
<td>10 mg/kg</td>
</tr>
<tr>
<td>Bupivacaine</td>
<td>~20 min</td>
<td>~4-6 hours</td>
<td>5 mg/kg</td>
</tr>
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</table>

Non-Pharmacological Methods of Pain Control

Non-Pharm… Post-op
- Monitor continuously until return of righting reflex
- Maintain warm
- Heat pads under 1/2 cage
- Place animal on warmed, open gel pack (added water source + heat)

Non-Pharm… Post-op
- Monitor for 5-7 days (unless local policies state otherwise). Longer if indicated
- Timing: Administer Rx (antibiotics, analgesics) close to their indicated therapeutic intervals
- Provide comfort & stress free environment (Nestlets, Enviro-dri, huts)

Non-Pharm… Extra Calories
- Reverses post-op catabolic state
- Makes it easier for them - Food at floor level

DietGel
clearh2o.com
Bacon Softies
bio-Serv.com
Normal Daily Intake

<table>
<thead>
<tr>
<th></th>
<th>Rat (~300 g)</th>
<th>Mouse (~25 g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food</td>
<td>~30 g</td>
<td>~4.5 g</td>
</tr>
<tr>
<td>Water</td>
<td>30-35 ml</td>
<td>3.5-5 ml</td>
</tr>
</tbody>
</table>

Non-Pharm... Social vs. Single Post Op Housing

- Single housing – The norm in most protocols, however...
- Rats spinal cord injury – 20% less chance of survival when housed individually
- Telemetric implant surgery, female mice - When housed socially needed less time to fully recover

(Van Loo et al., 2007)

Post op

- Know what a healthy animal looks like
- Then know signs of a painful & ill rodent
- Compare weight to baseline – A sudden change in body weight is often indicative of health or welfare problems

Pain Assessment

- Appearance
- Activity
- Feeding behavior
- Vocalizations
- Grimace scale
- Alterations in physiological parameters

The sick & painful rodent

Both mouse and rat have starey (piloerection of guard hairs) coats and a poor body condition

The sick & painful rodent

Porphyrin staining (chromodacryorrhea)
Porphyrin – red-brown pigment secreted from Harderian gland in rats. Porphyrin usually removed by grooming. Build up often indicative of pain or stress
The painful rodent

Abdominal presses and extension of the hind-limbs indicative of abdominal pain

Back arching & squinted eyes

Grimace Scale

Thank You

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