This presentation contains potentially disturbing situations or content that may be distressing to some learners.

When Tension is High -

Surgical Gymnastics to Close Large Wounds

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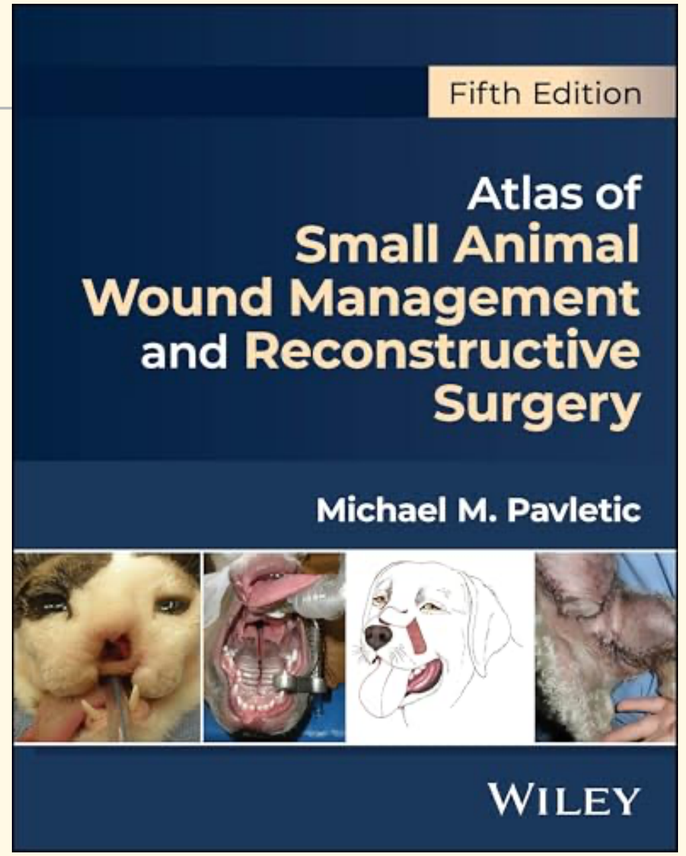
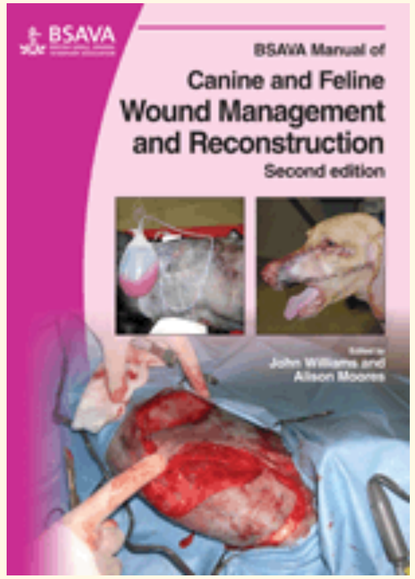
Wounds - Resources

- Pavletic - THE BOOK
  - 5th Edition - 2025
- BSAVA Manual
  - 2nd Edition - 2009





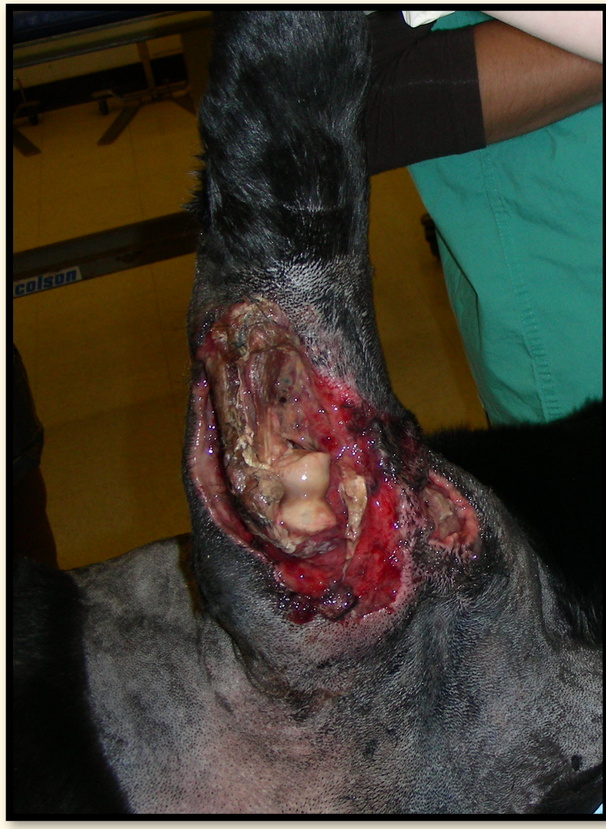
Wounds - Viability

Obviously not

That’ll be fine

Could go either way

Give it time!



Wounds - Viability

First instinct - Just suture that

Looks great

Owner happy

You can do stuff that you can get paid for

Only if

Contamination is controlled

Drainage is provided

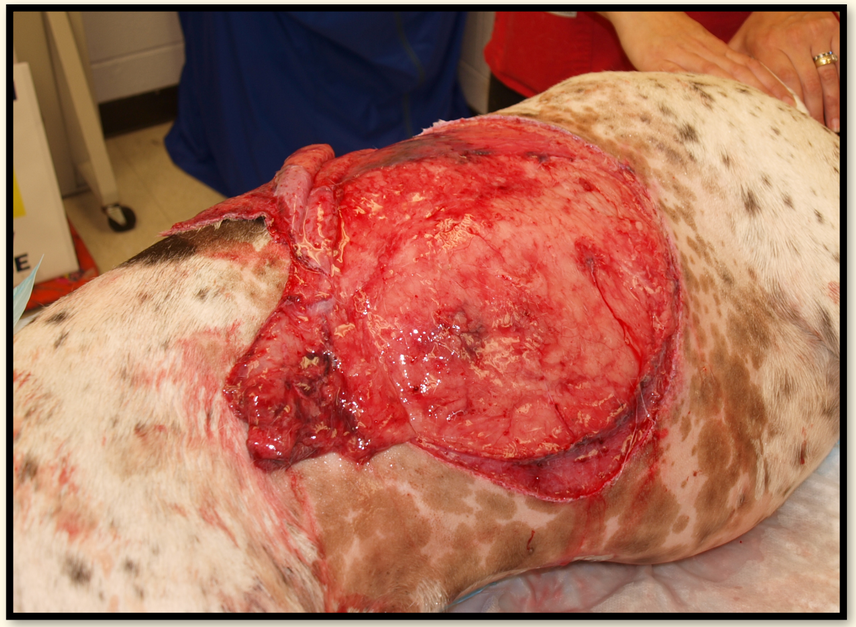
DO NOT SUTURE BITE WOUNDS!

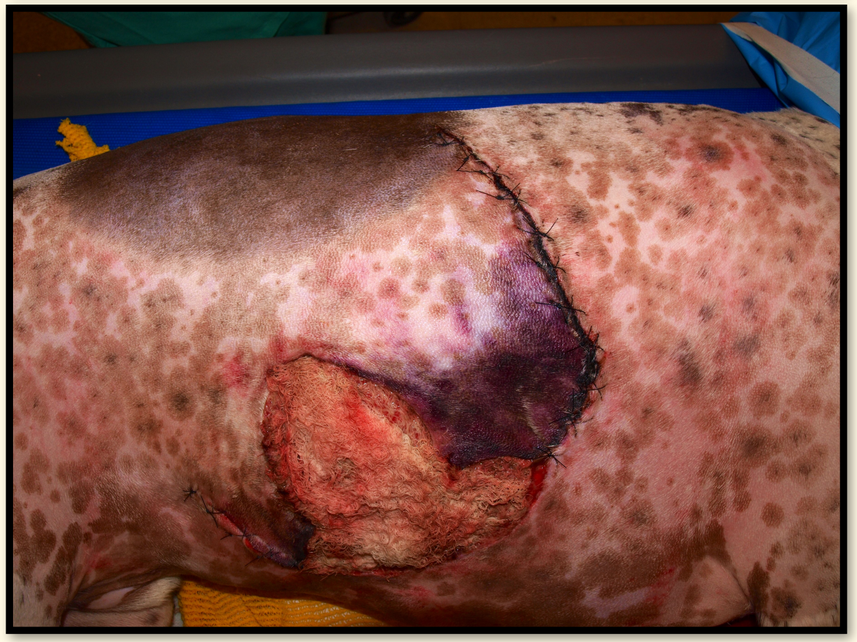
Wounds - Viability

Time to declare

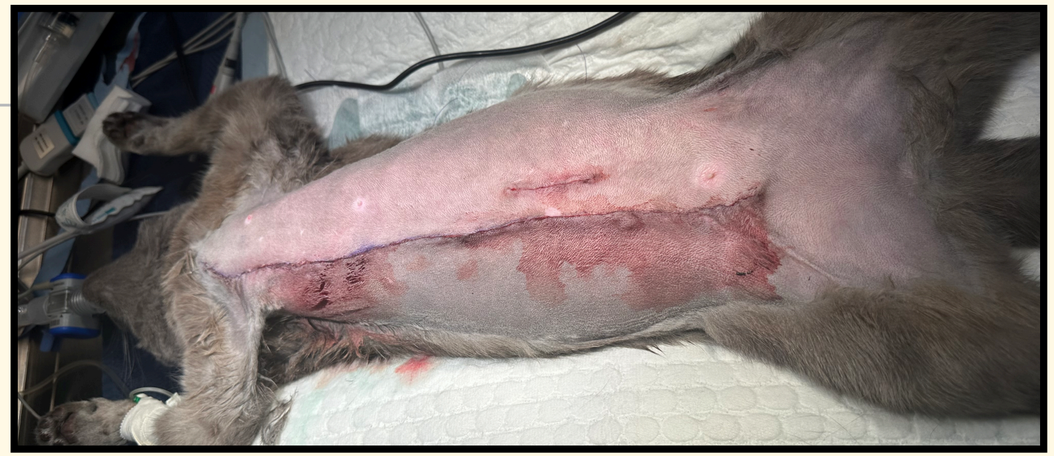
Open wound management

Delayed primary closure or 2nd intention healing





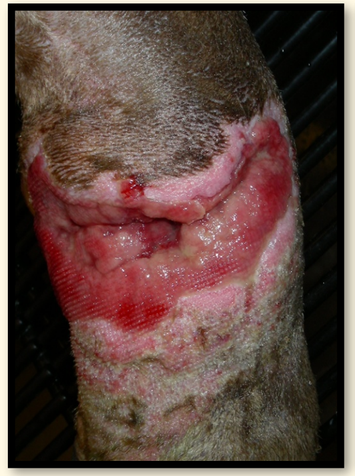
Wound Closure - General

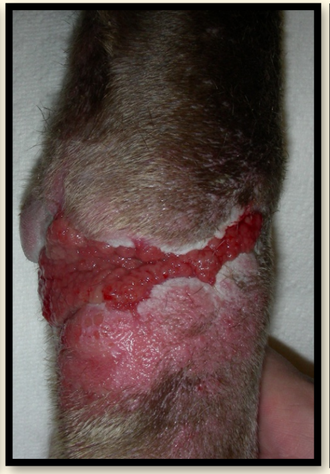


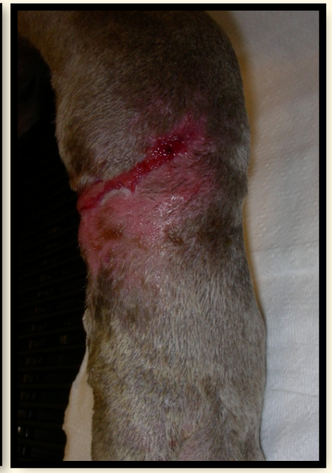
Primary Intention/Closure

No delay in surgical closure

Clean & clean contaminated wounds





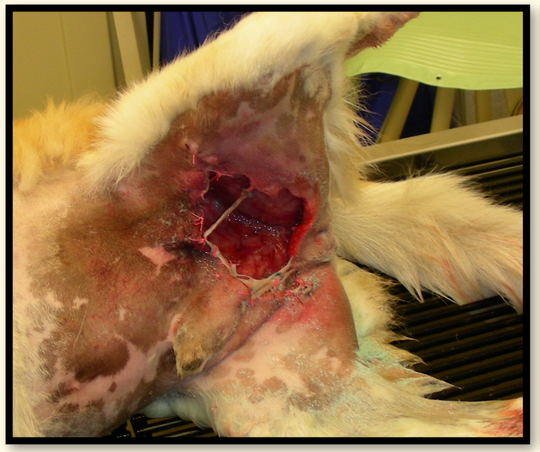


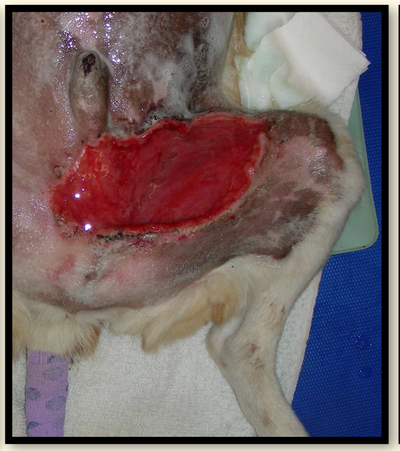
Secondary Intention

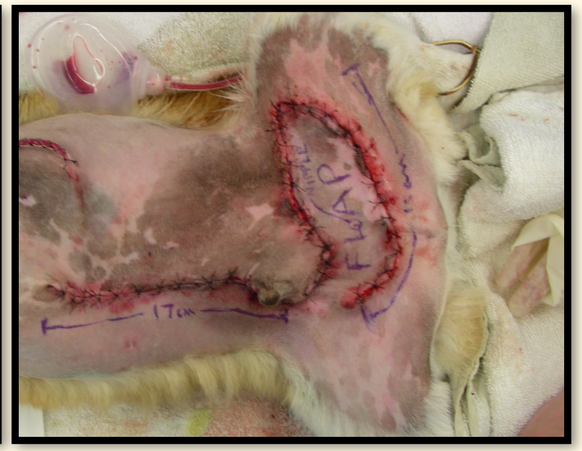
Closure without surgery

Tertiary Intention - Delayed Primary Closure

Granulation tissue present







Surgical Wound Closure

Surgical closure techniques can be applied in both primary and delayed primary closure

- Primary apposition
- Flaps

Ground Rule: Healthy wound tissue

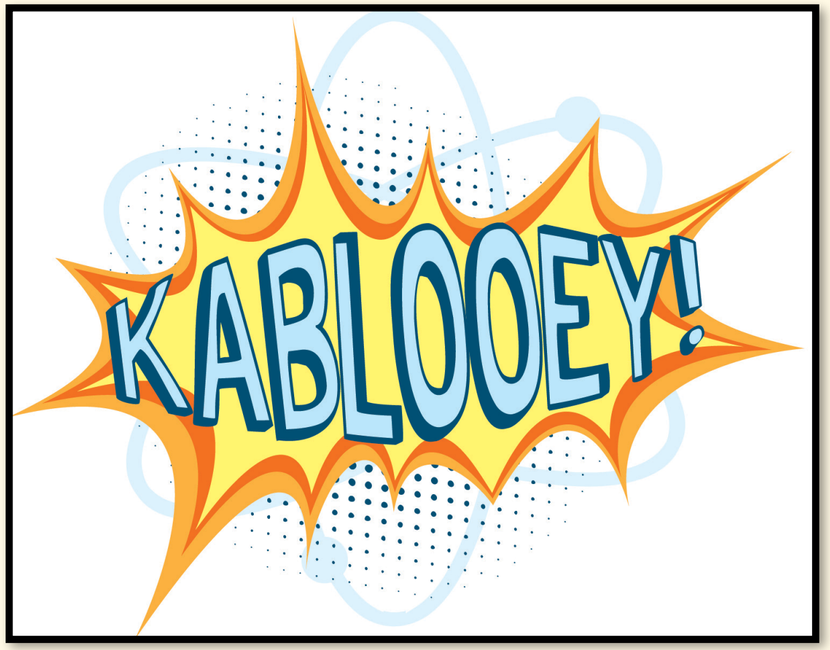
- Surgical wound
- Healthy granulation tissue

Surgical Wound Closure

Why does wound closure fail?

- Tension
- Contamination
- Dead Tissue
- Drainage Issues
- Infection
- Dehiscence

If in doubt, leave it open



Tension!

Major reason for failure

- Poor perfusion > Necrosis > Dehiscence

Tons of options to avoid

- KISS principle
  - Use simplest method possible
  - Plan A, B, and C
  - Open wound management always option Z

Tension - Consideration

Skin is elastic

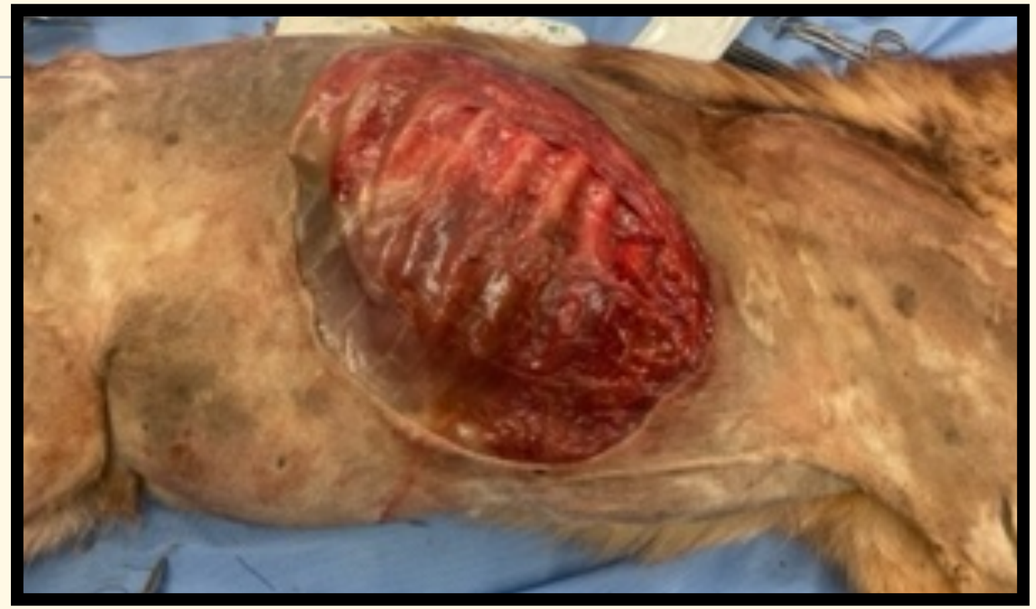
- Species differences

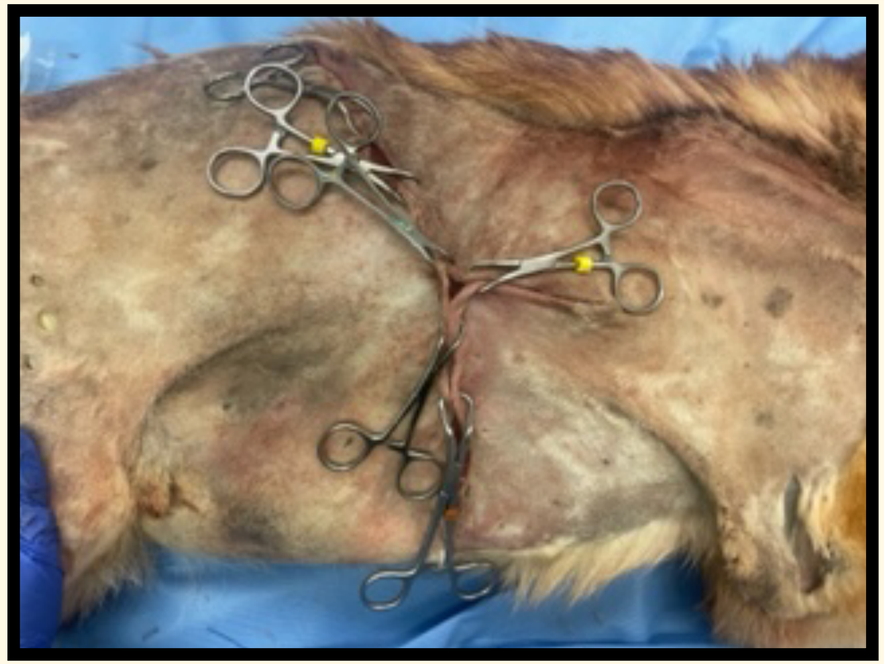
- Patient differences
  - Breed
  - BCS

- Area differences
  - Location
  - Tension lines

Tension Lines

- Depend on directional elasticity
- Incise parallel to tension lines
- Diagrams! - Not walk around knowledge
- Treat the patient, not the picture
  - Pinch the skin prior to incision to feel
  - Use towel clamps to appose tissue prior to closure



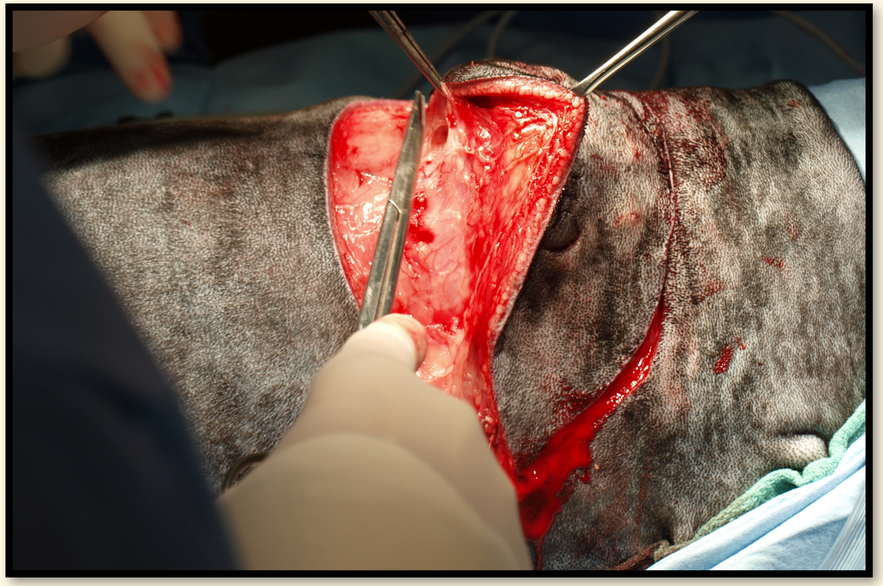


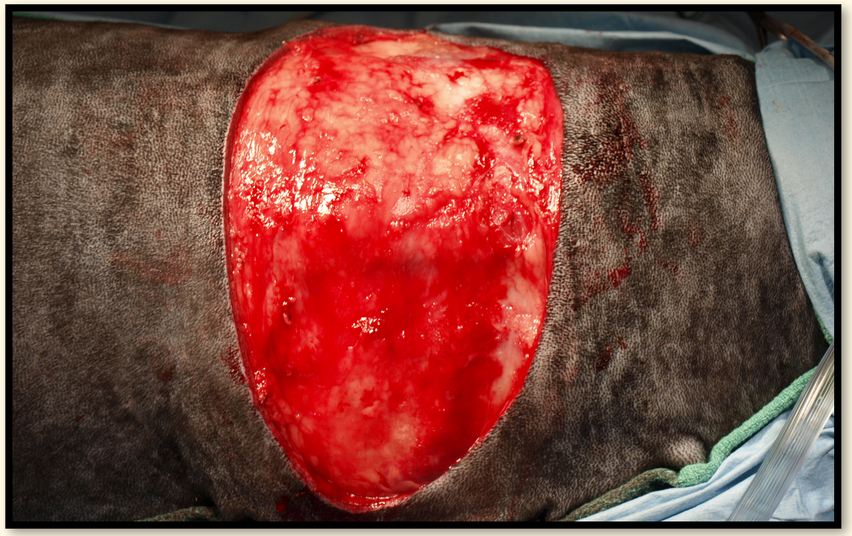
Images courtesy of Dr. Clara Moran

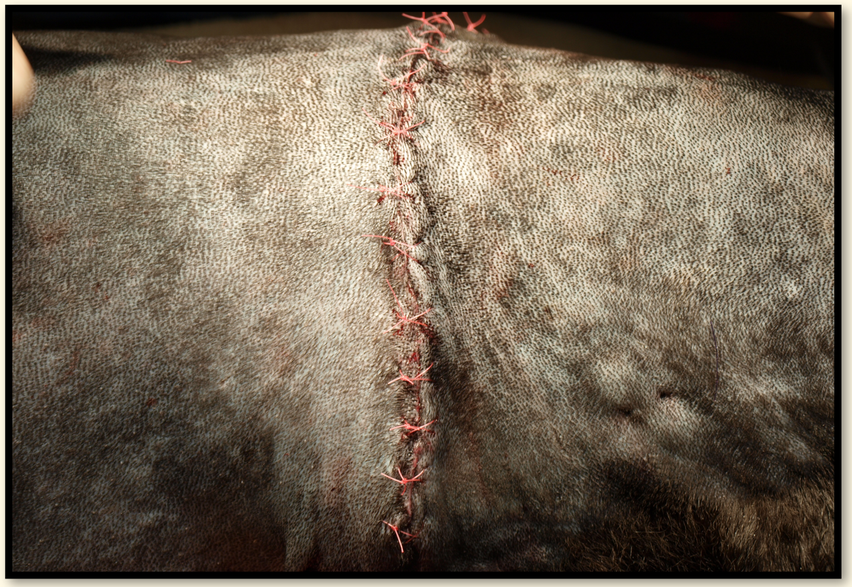
Surgical Wound Closure - Primary Apposition

- Surprisingly effective

- Undermining
- Walking sutures
- Releasing incisions
- Stents/Bolsters
- “Alphabet plasty”







Surgical Wound Closure - Undermining

Blood supply to skin

- Direct cutaneous vessel
- Subdermal Plexus - Powerful!

Sharp and blunt dissection

- DEEP to cutaneous trunci!
- Preserve direct vessels when possible
- Forceps = Crushing Trauma

Surgical Wound Closure - Undermining

Creates dead space - Drainage?

Very effective

- Loose skin
- Big flat areas
- Technique ranges from minimal to maximal effort - Thorax vs. Lateral thigh

Don’t get too close to the dermis

Surgical Wound Closure - Walking Sutures

Combined with undermining

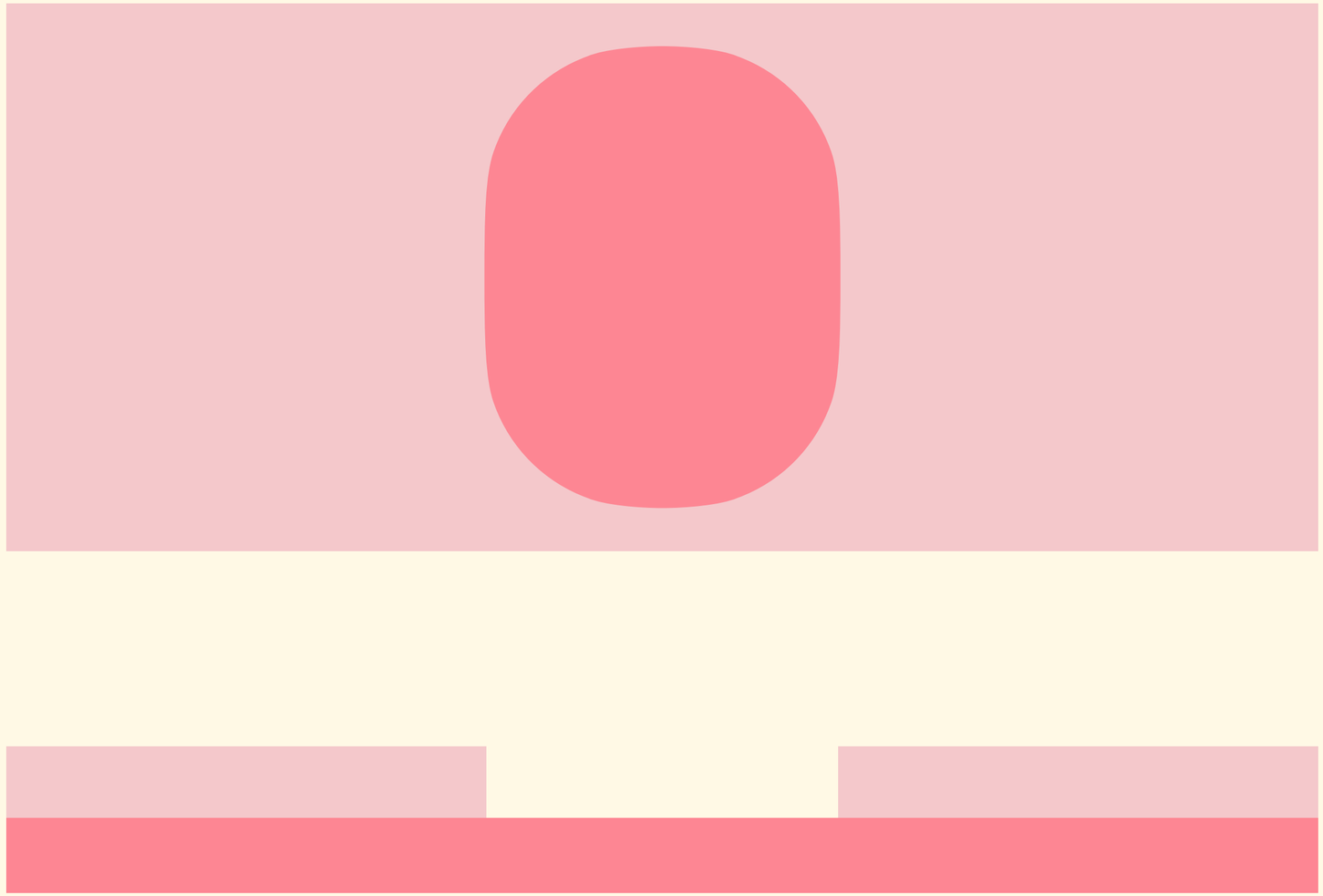
- Advancement of peripheral skin toward center
- Buried Sutures

- Peripheral sutures that take up some of the tension

- Important:
  - Orientation
  - Spacing

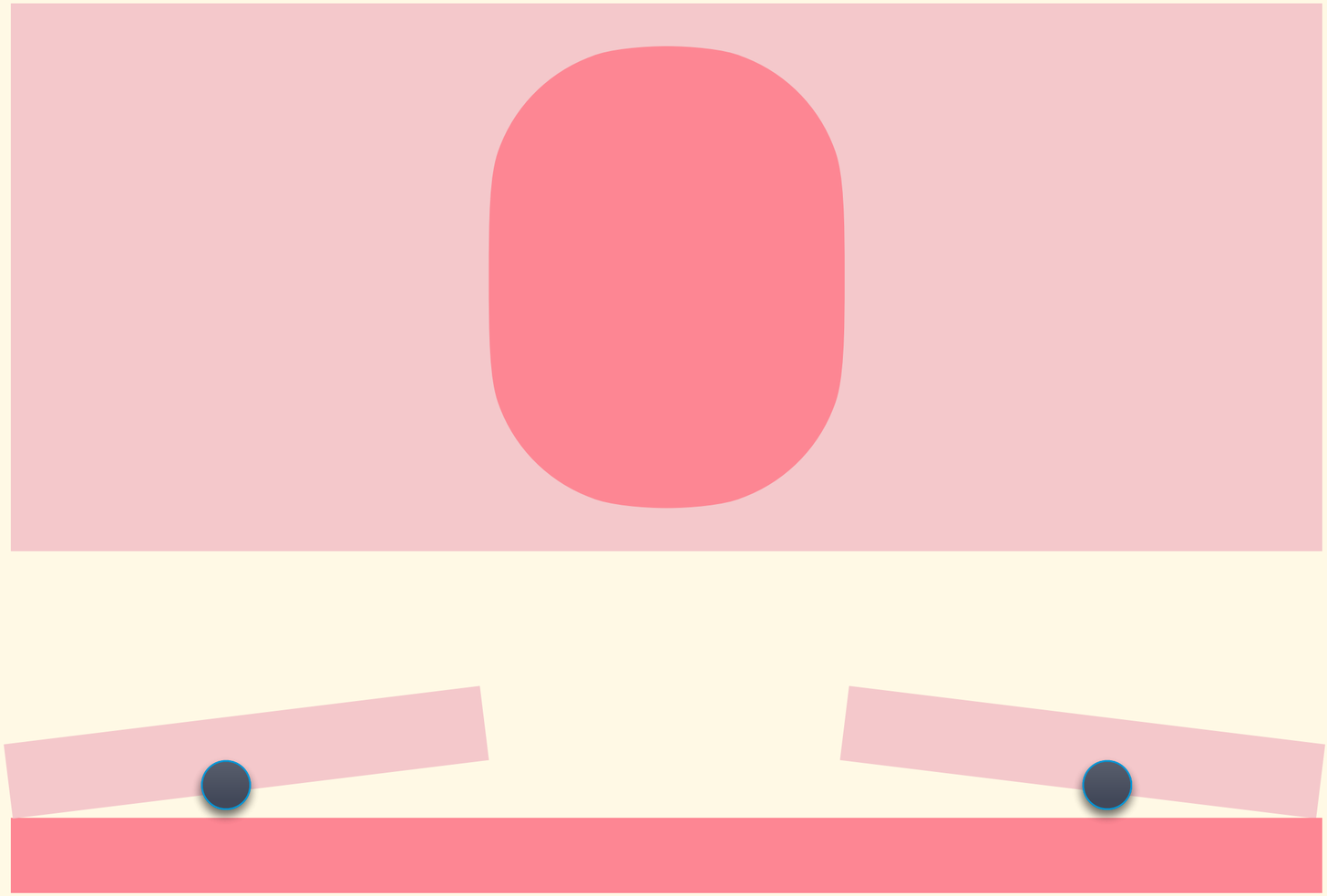
Surgical Wound Closure - Walking Sutures

- Undermine



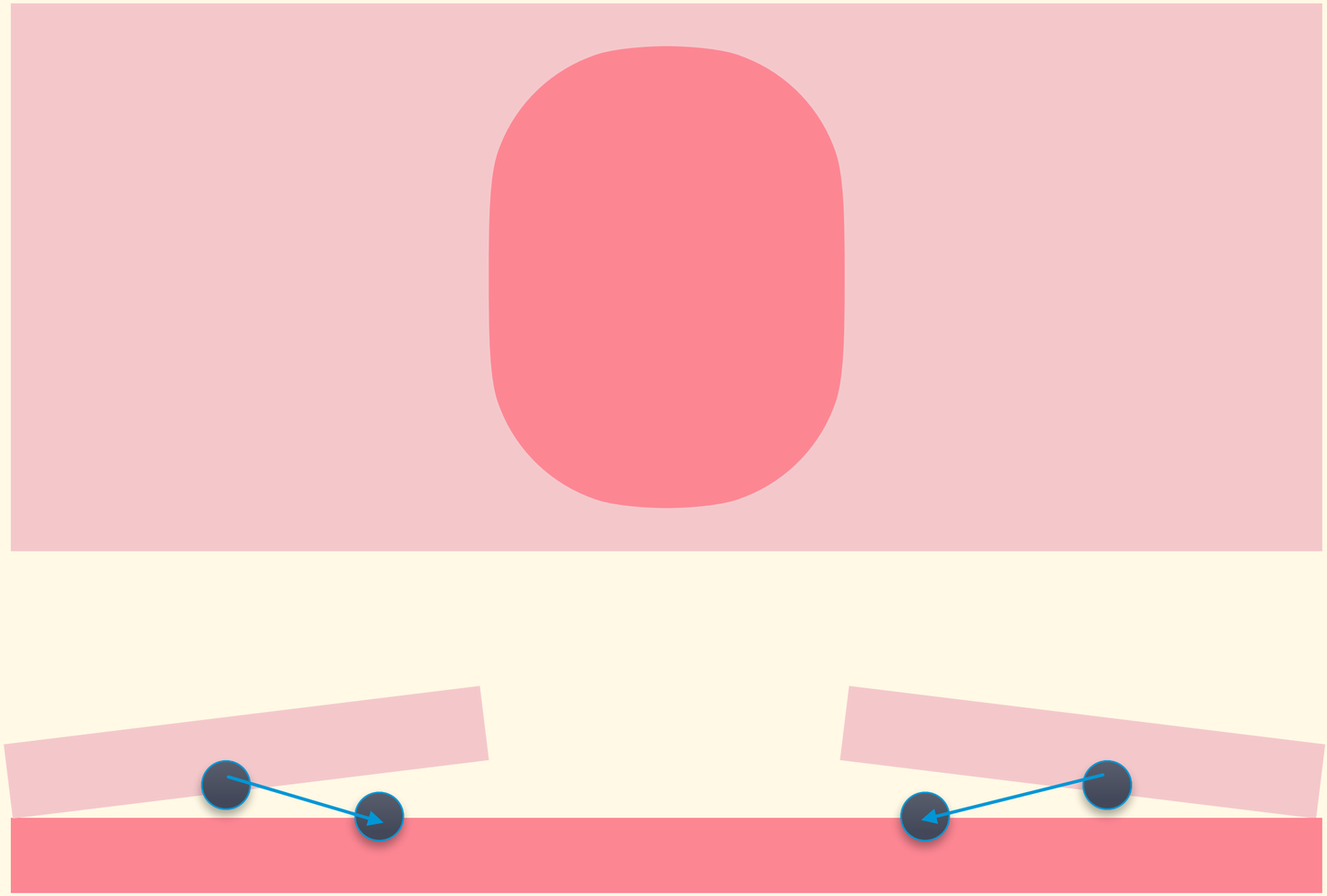
Surgical Wound Closure - Walking Sutures

- Undermine
- Bite deep in skin to be advanced



Surgical Wound Closure - Walking Sutures

- Undermine
- Bite deep in skin to be advanced
- Suture to wound bed towards center



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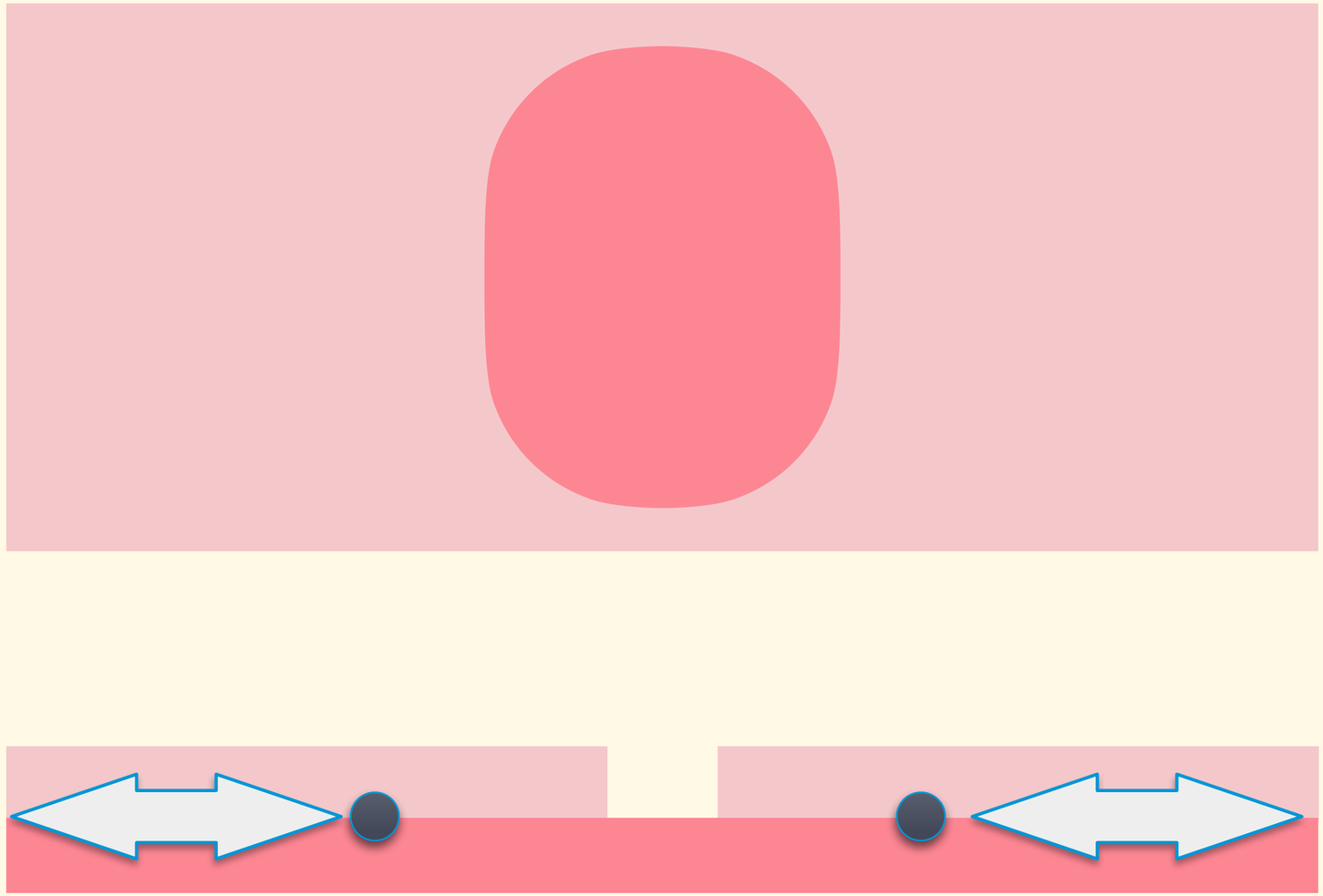
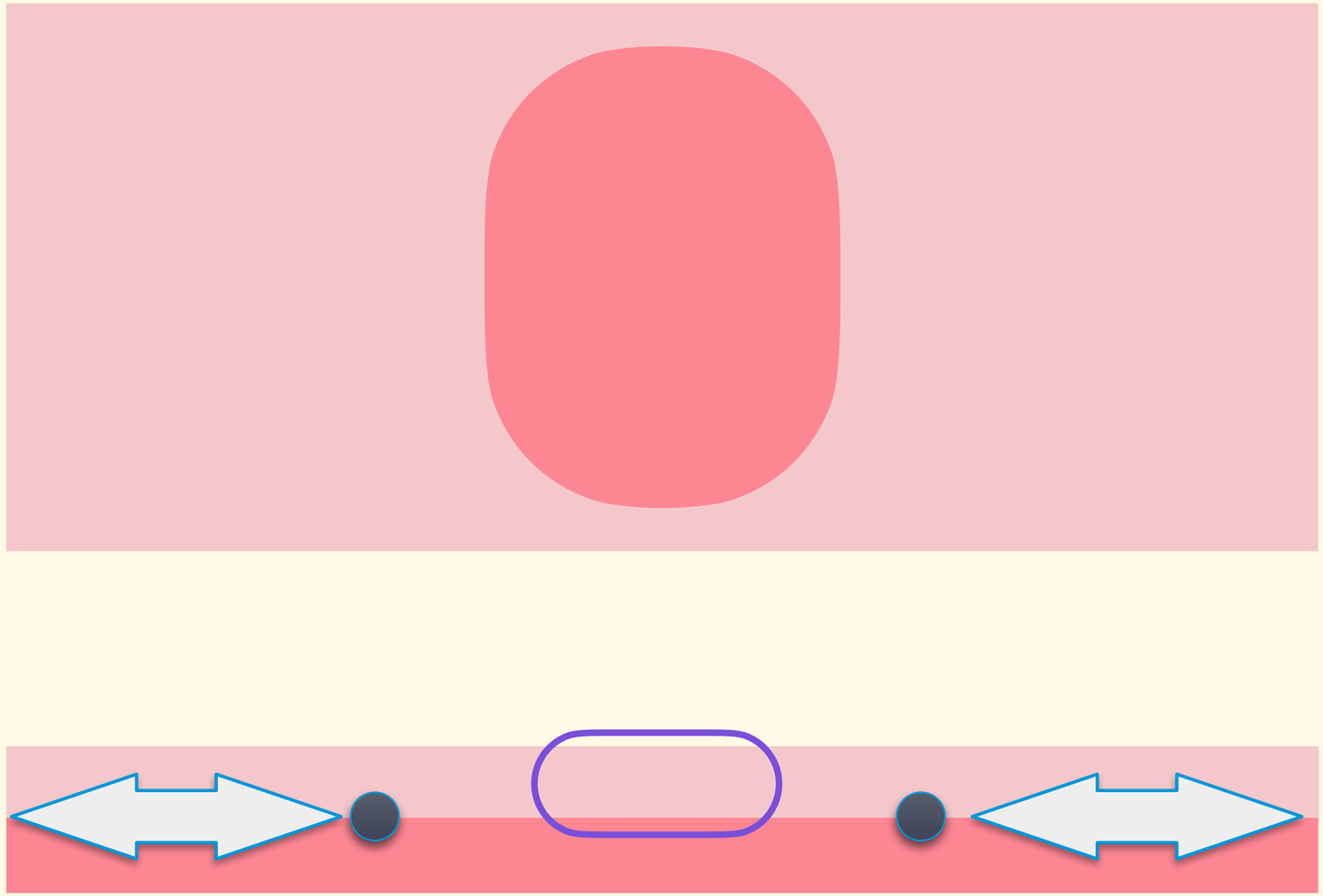


Surgical Wound Closure - Walking Sutures

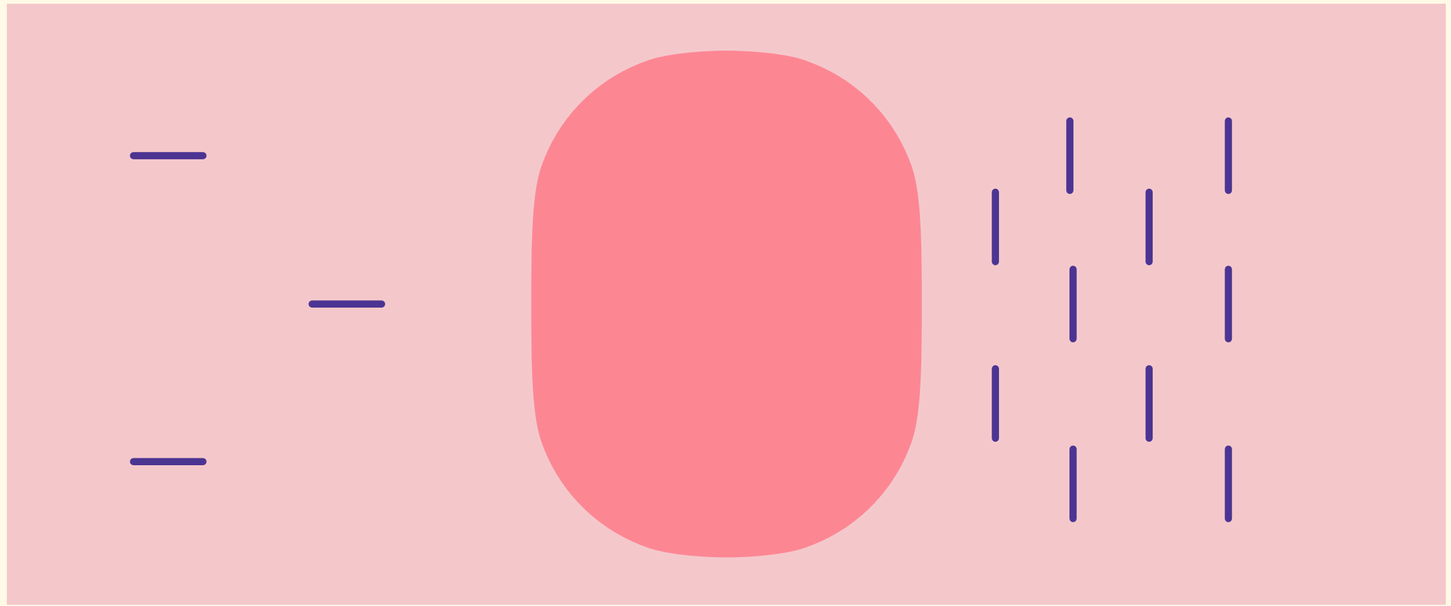
- Undermine
- Bite deep in skin to be advanced
- Suture to wound bed towards center
- Appose wound edges



Surgical Wound Closure - Releasing Incisions

- Suture orientation
- Spacing/Numbers

- A or B?



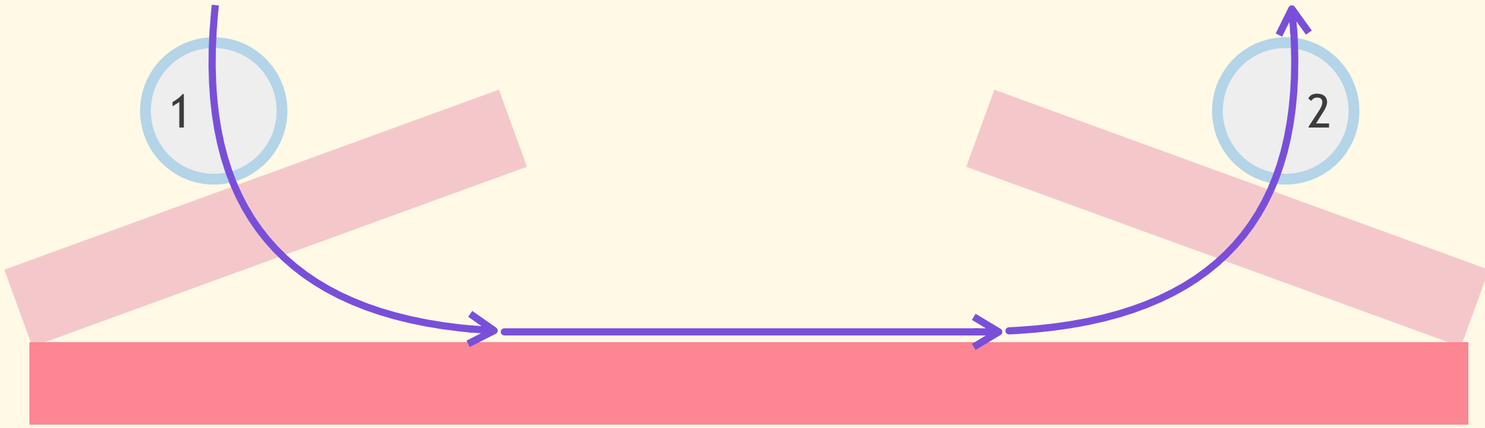
A But: Dimples! B

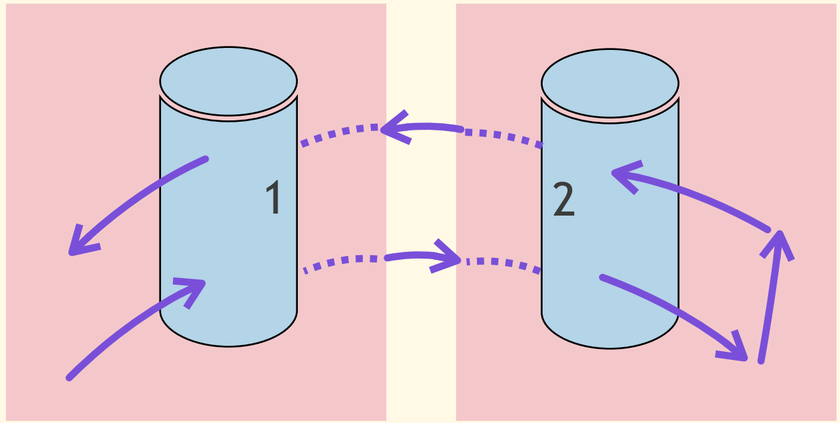
Tension Relief - Stents and Bolsters

- Combining Advantages:
  - Horizontal mattress sutures
  - Spreading pressure over a larger area
  - “Brace” the wound closure line
- Stents:
  - Tubing: IV tubing, red rubber
- Bolster ≈ Tie-Over Bandage
  - Suture loops take up Tension

Tension Relief - Stents

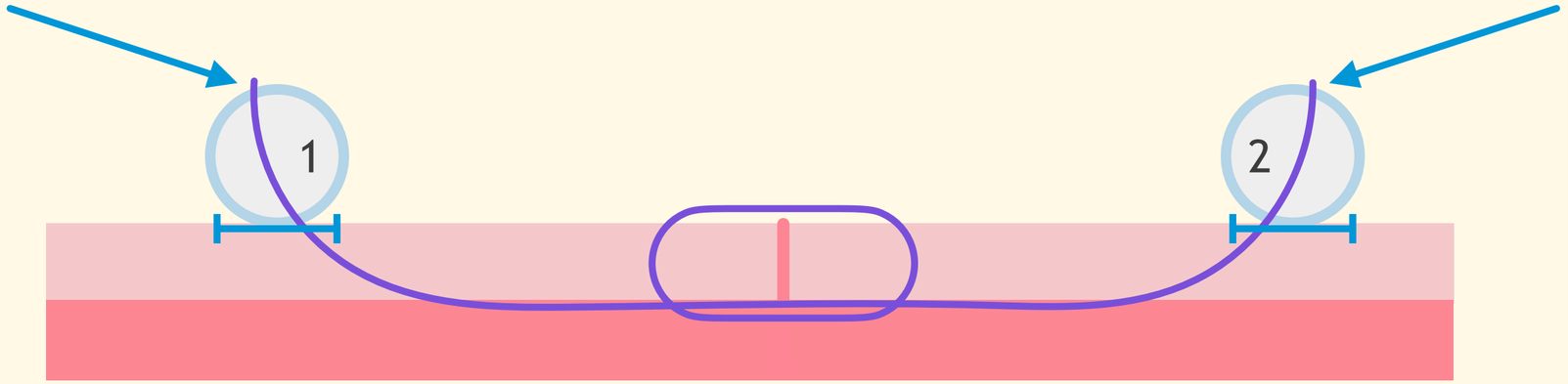
- Stent 1 & skin
- Skin and stent 2 on opposite side
- Stent 2 and skin (horizontal mattress pattern)
- Skin and Stent 1
- Tie over stent 1





Tension Relief - Stents

- Line pressure from suture distributed over stent contact area



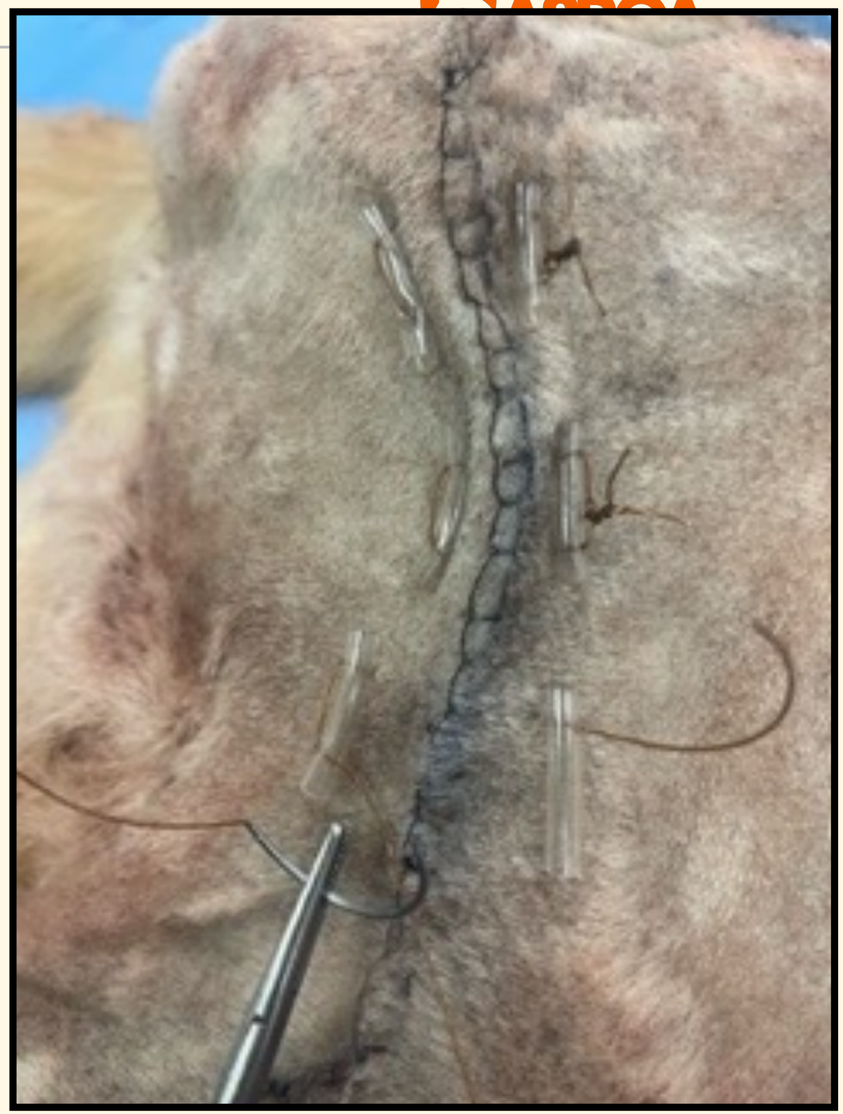


Image courtesy of Dr. Clara Moran

Stents

- Can also route suture through stent lumen
- Remove after 3-5 days
  - Skin stretch
  - Pressure necrosis

- Suture tension?
  - Goldilocks!

Buttons?

- Described use as “stenting material”
- Hard = Pressure necrosis
- 0 Stars, do not recommend

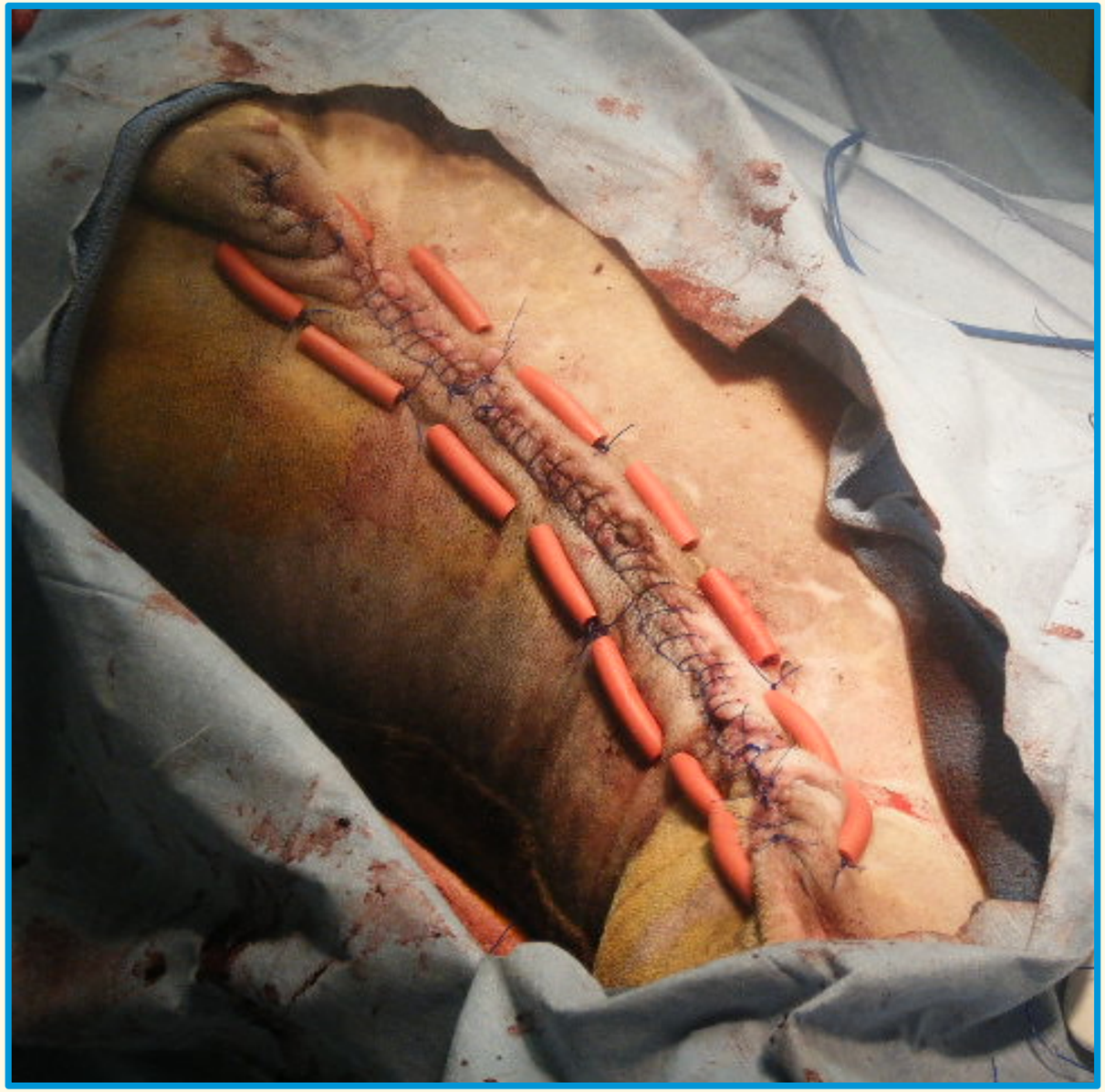


Image courtesy Dr. Clara Moran

Tension Relief - Bolsters

- Tie-Over Bandage
- Suture loops - umbilical tape laced through loops and across wound
- Tied over towel or lap sponge

- BIG bites for suture loops
  - Large diameter suture: 2-0, 0 or 1
    - 2-0 minimum

Tension Relief - Releasing Incisions

- Short, multiple - “Pie crusting”
- Long, single - Bipedicle advancement flap

- Closure
  - Second intention
  - Primary closure

Tension Relief - Releasing Incisions

Why would you do that?

- Secondary area is easier to deal with
  - Tension
  - Cleanliness
  - Fresh/healthy wound

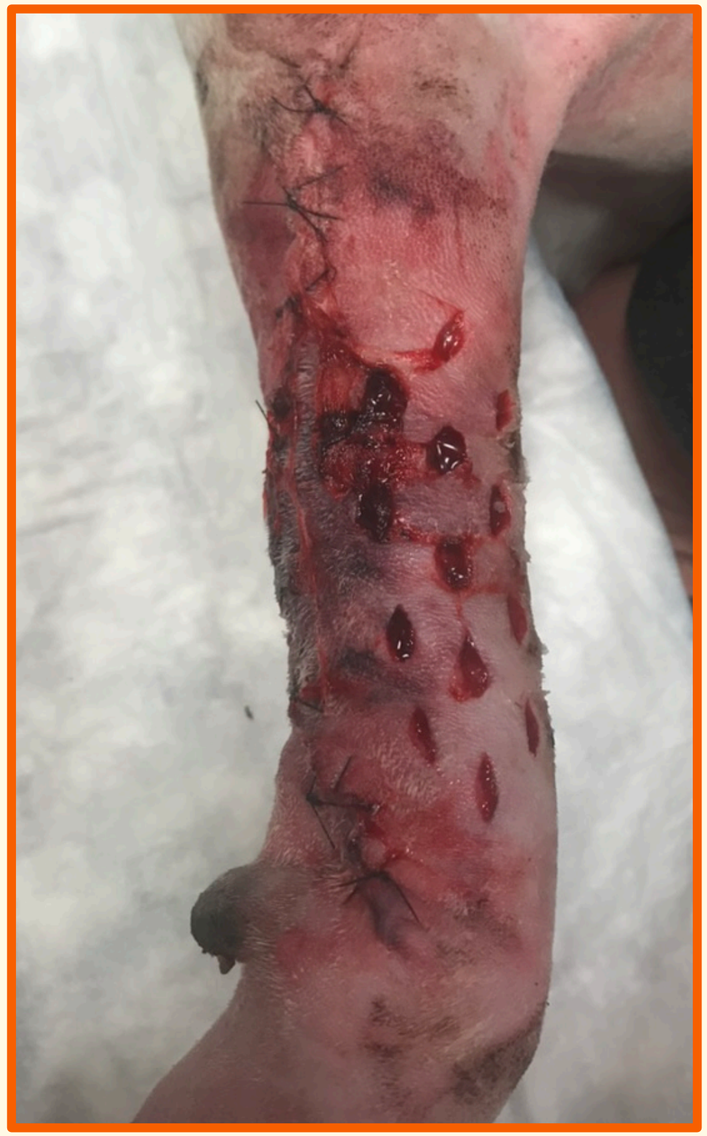
- Extend undermining area

- Small openings can heal through second intention

Tension Relief - Releasing Incisions

- Think through this before doing it!
- Bipedicle flap covered later

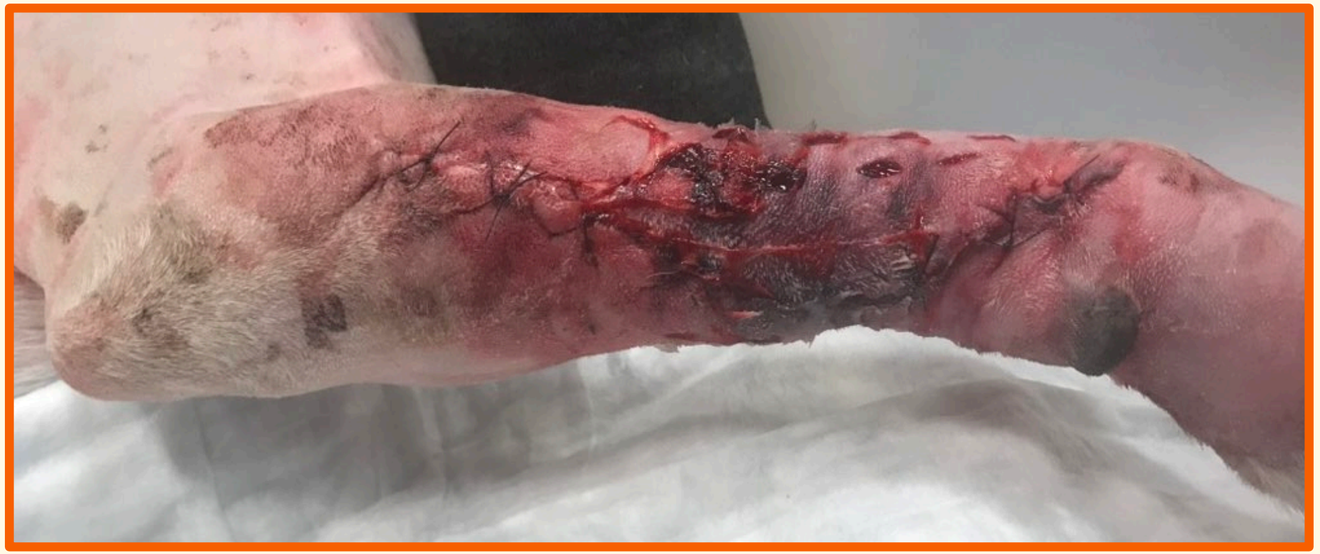
- Multiple releasing incisions - “Pie crusting”
  - Extremities
  - Tension relief limited
  - Orientation is important



Tension Relief - Releasing Incisions

Technique

- Full thickness - Epidermis & dermis
  - Will not release otherwise
  - Should gap!
  - 5-15 mm length
- Orientation: Where is the blood supply coming from?
  - Avoid transection - long axis of limbs
  - Staggered rows



How many? How close together? How many rows?

Tension Relief - Releasing Incisions

Bipedicle Advancement Flap

- Form of random pattern skin flap
- Wait, what's a flap?

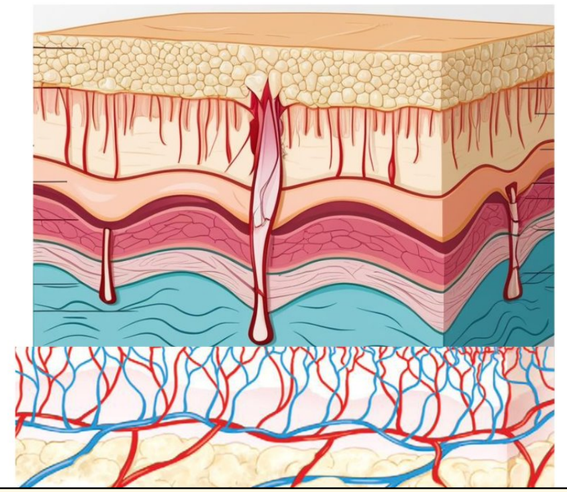
Tension Relief - Flaps

Local subdermal flaps

– Random

– Rely on subdermal plexus for blood supply

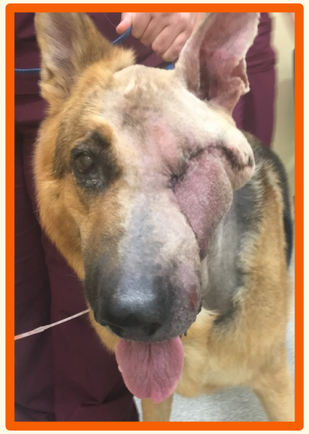
– Size limit

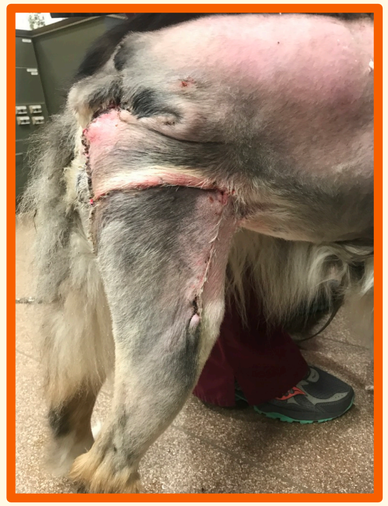


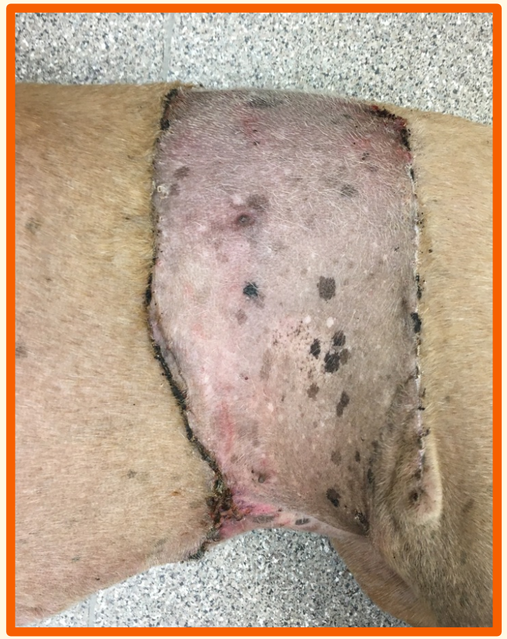
Axial pattern flaps

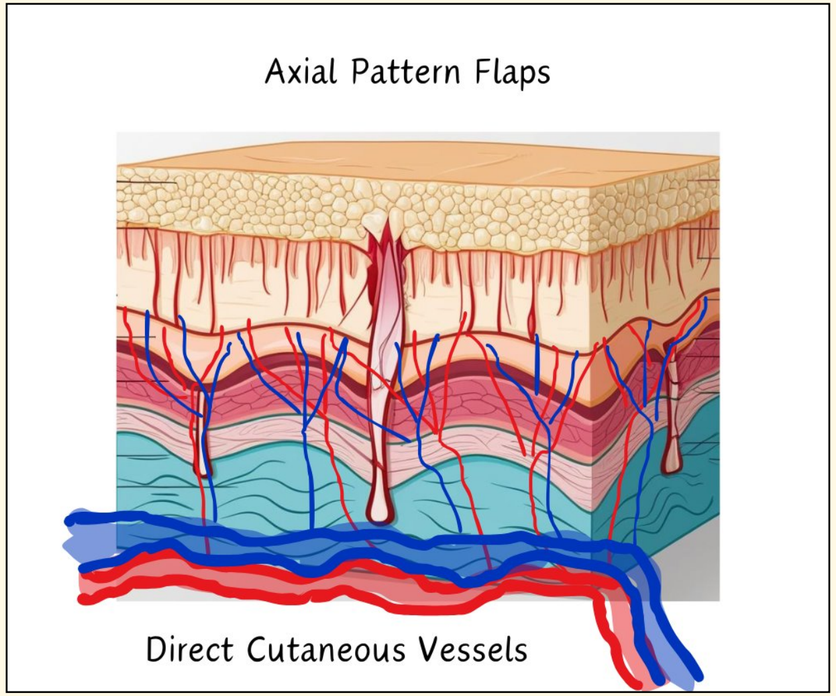
– Direct vessel - named

– Can be large









Photos: VetSSMART created via Canva

Tension Relief - Flaps

Principles

– Base of flap is wider than the tip
– Flap dimensions sufficient to close defect
  • Minimize tension
– Consider motion
  • Tension
– Drainage

KISS principle applies

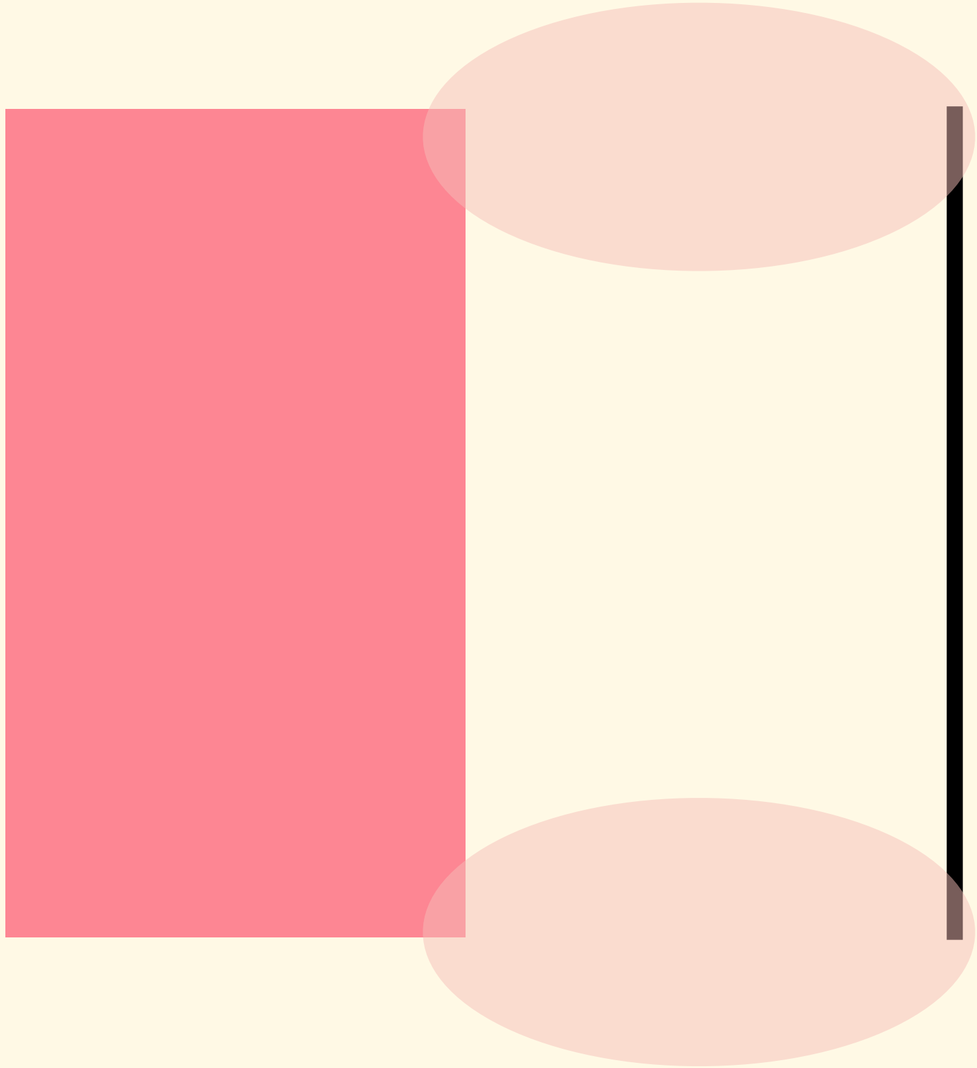
Local Subdermal Flaps

- Still rely on direct blood supply (vs. graft)
- Base(s) supplying blood supply - Pedicle
- Keep the Panniculus muscle

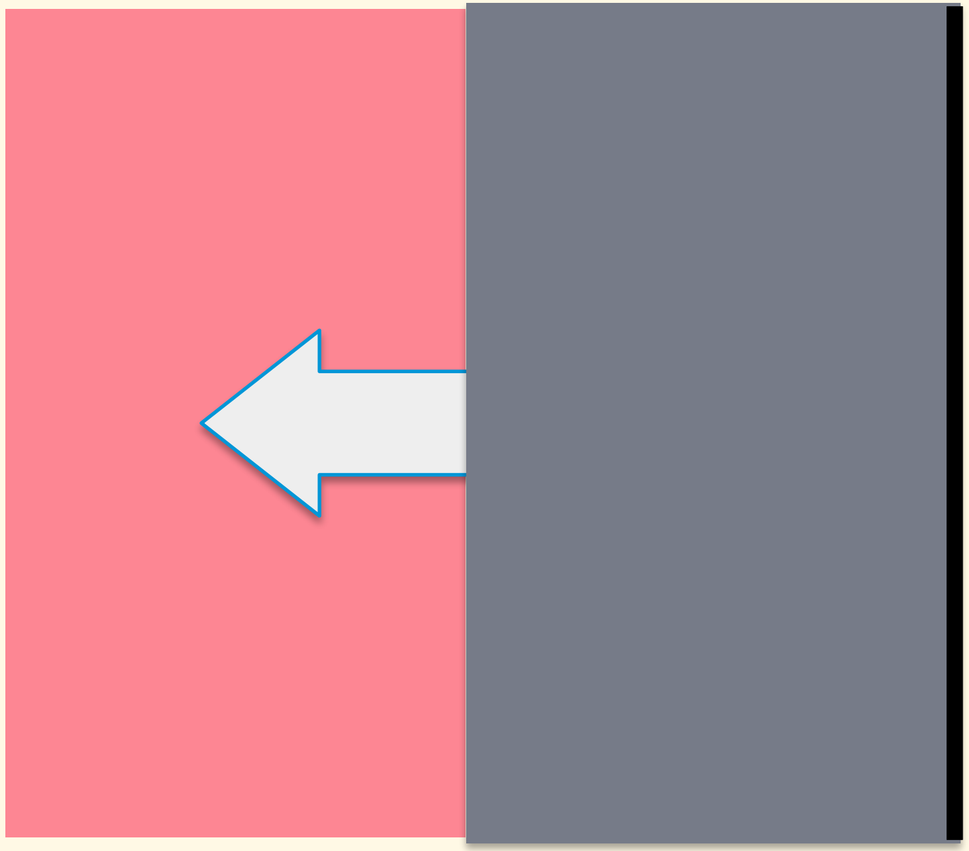
Types

- Advancement
  - Bipedicle
  - Single Pedicle
- Rotation
- Transposition

Local Subdermal Flap - Bipedicle Advancement



Local Subdermal Flap - Bipedicle Advancement



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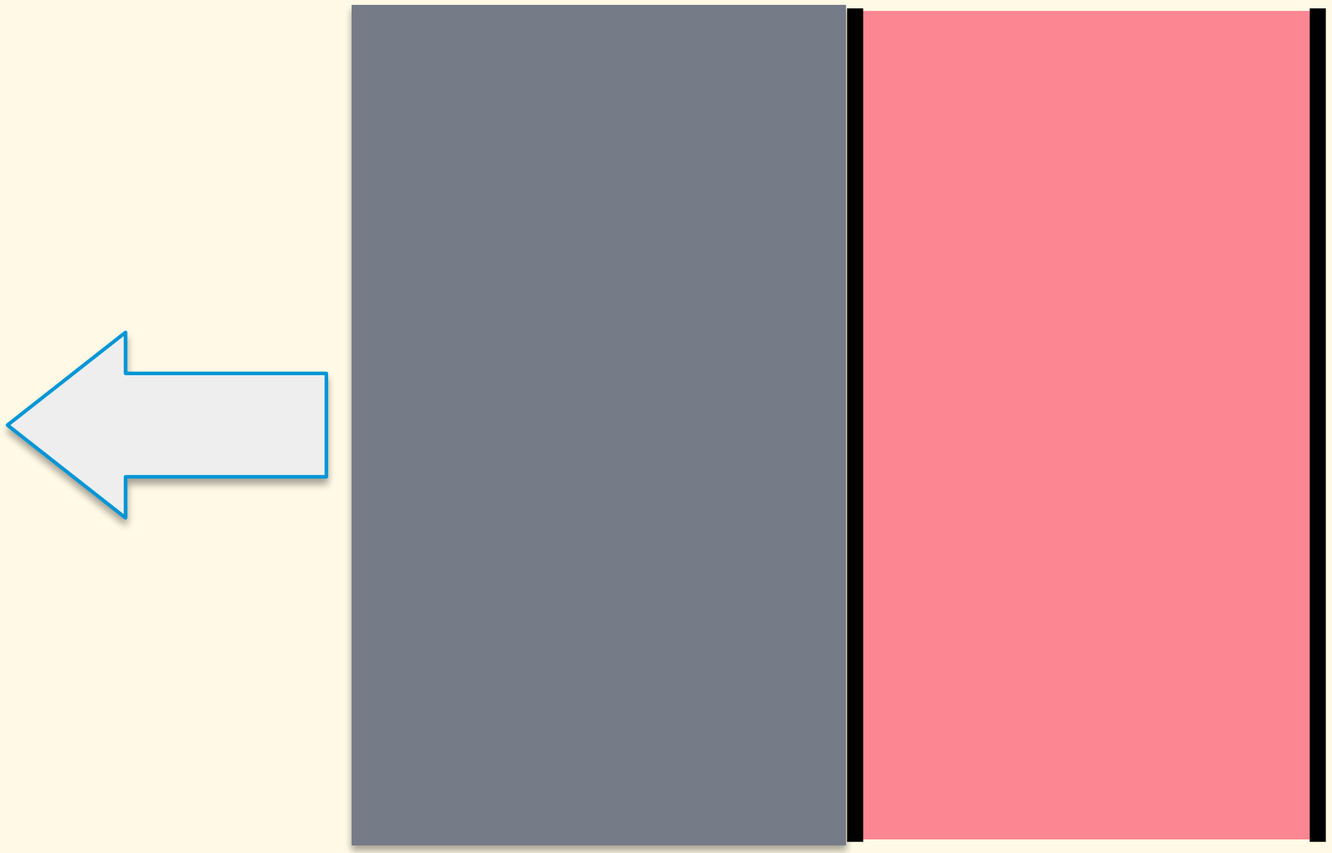

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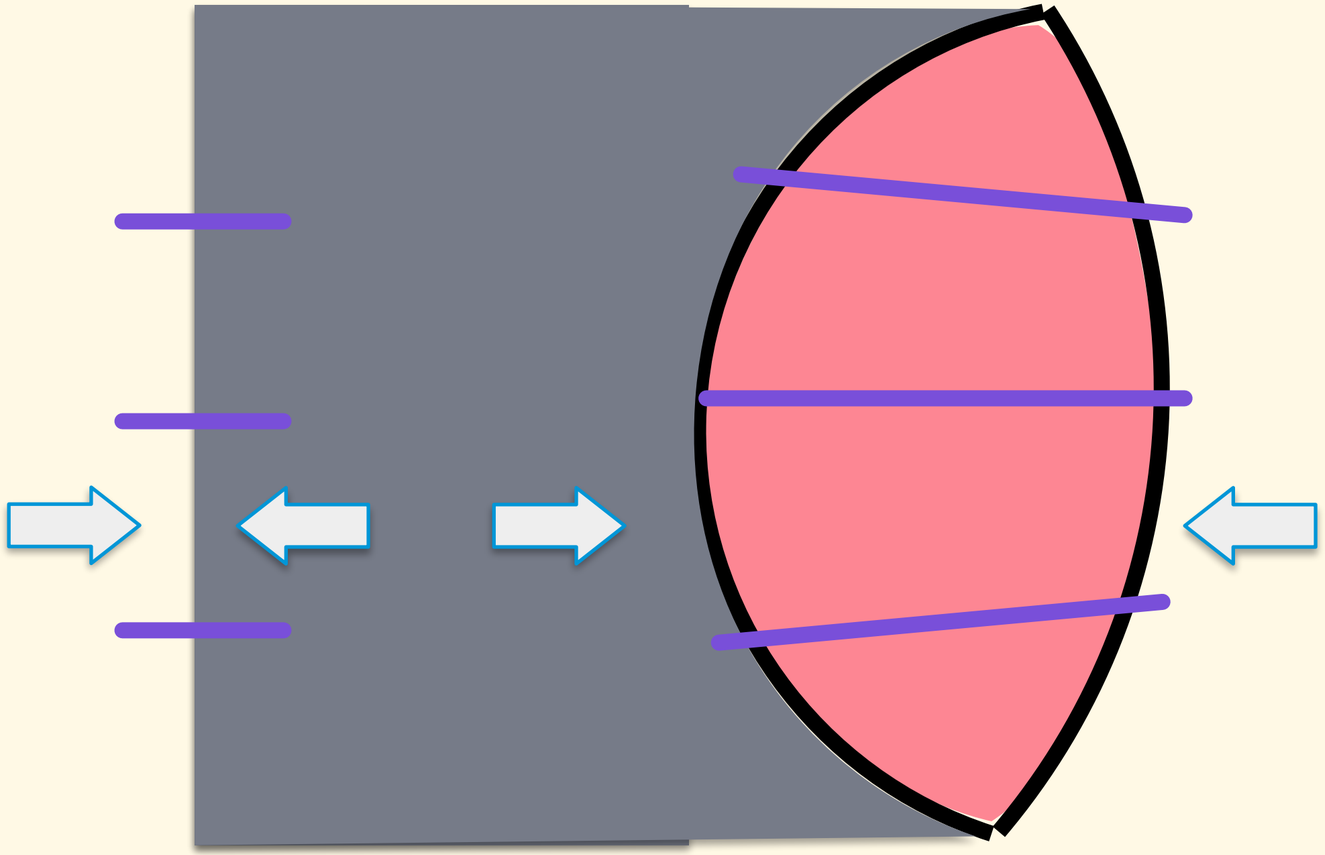
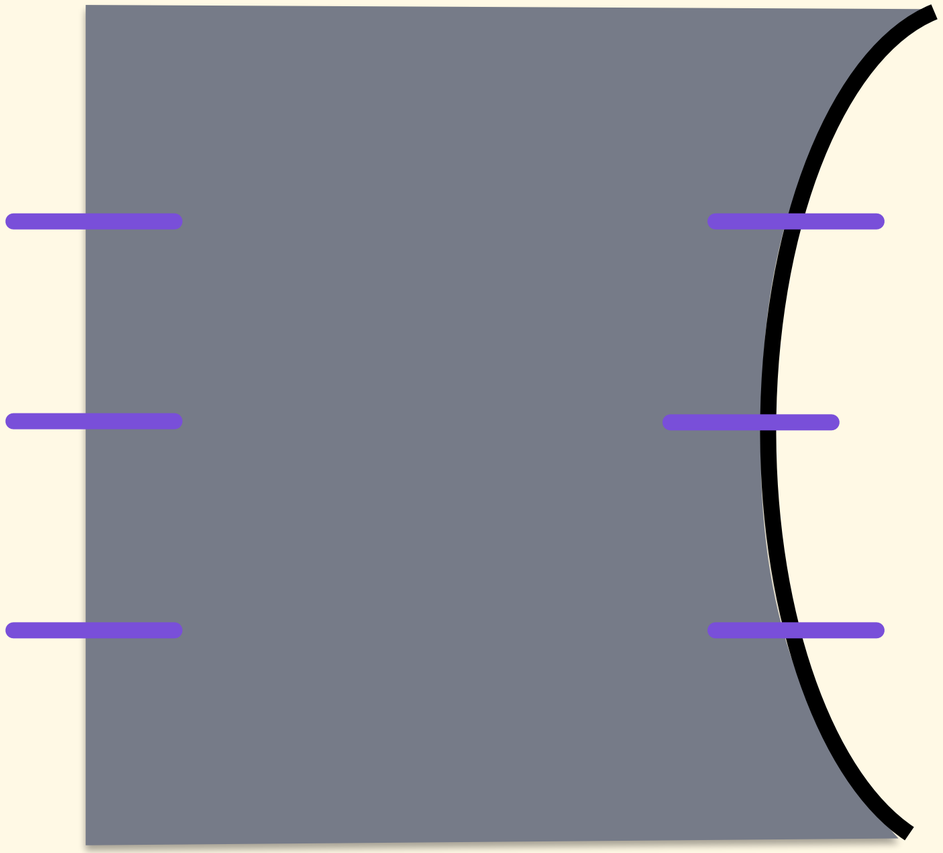
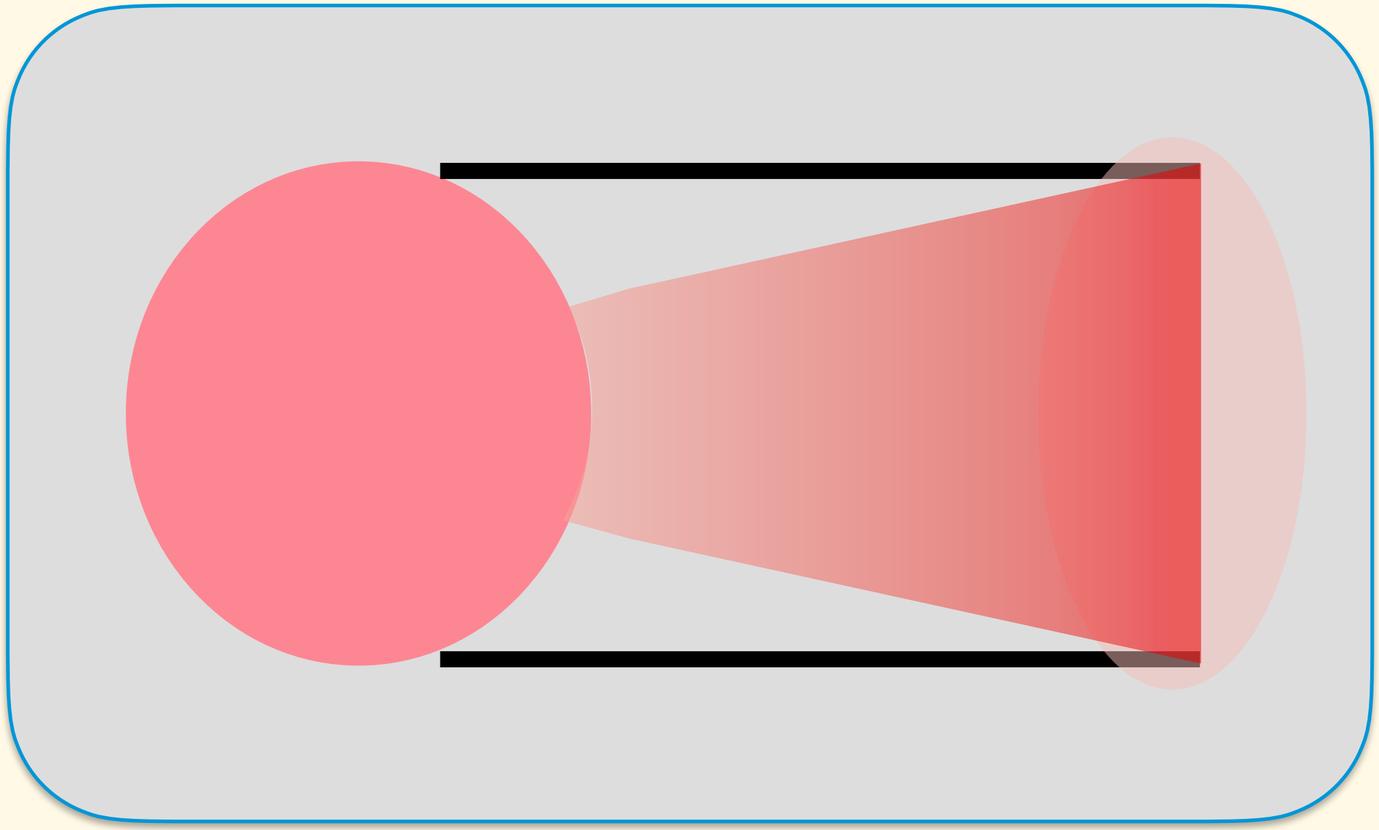


Local Subdermal Flap - Bipedicle Advancement



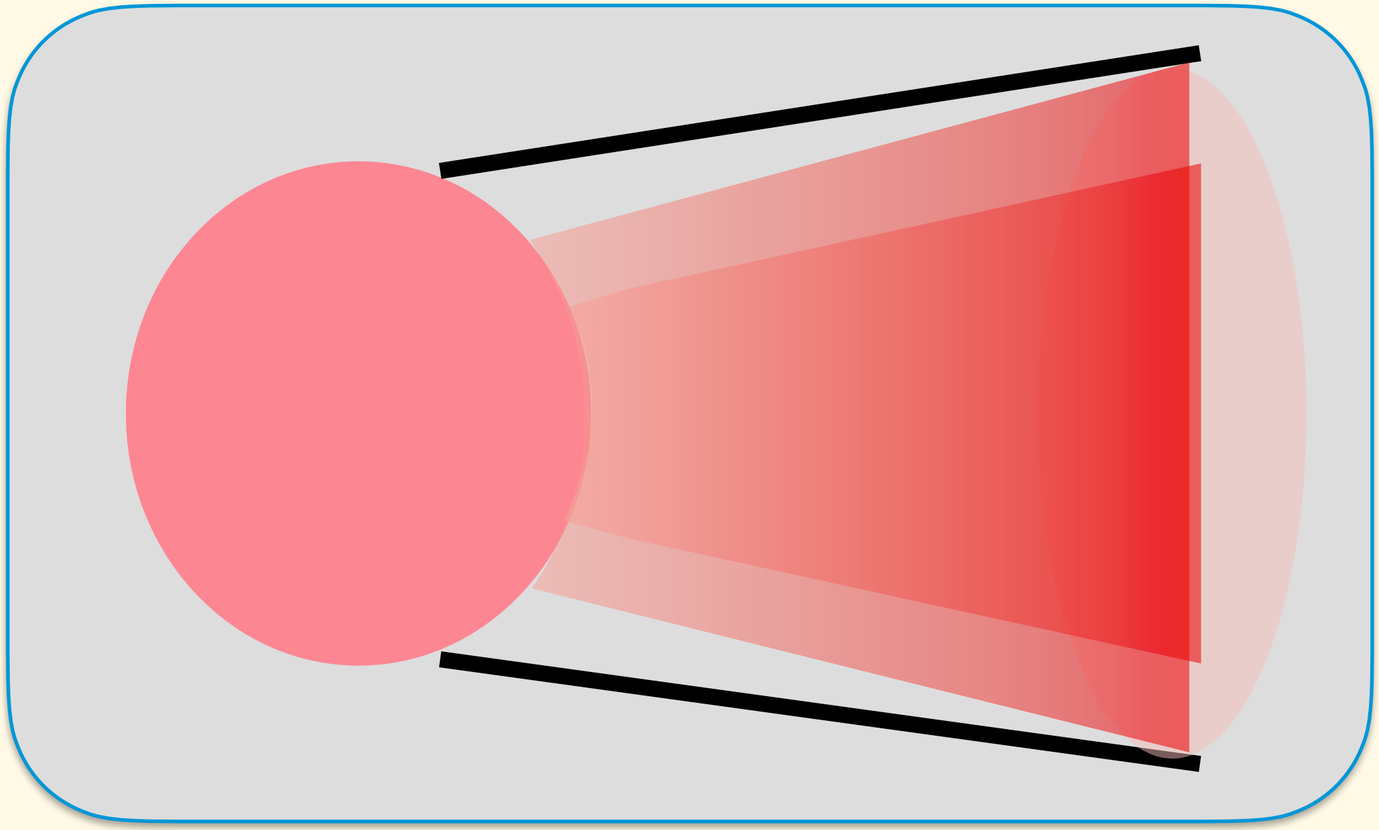
Local Subdermal Flap - Single Pedicle

- Shared border with wound
  - Skin is pulled into wound without pivoting



Local Subdermal Flap - Advancement

- All about that base



Local Subdermal Flap - Advancement

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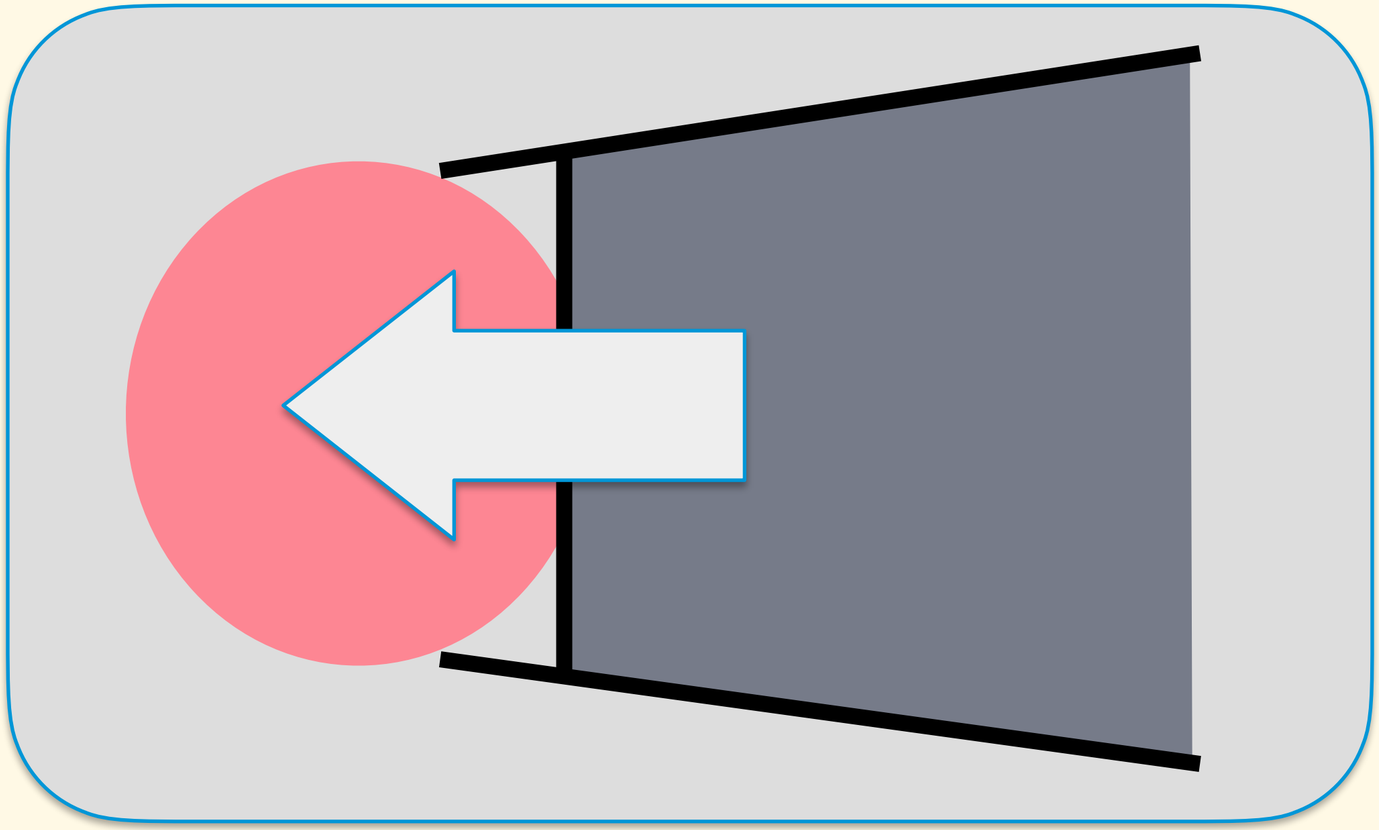

Local Subdermal Flap - Advancement

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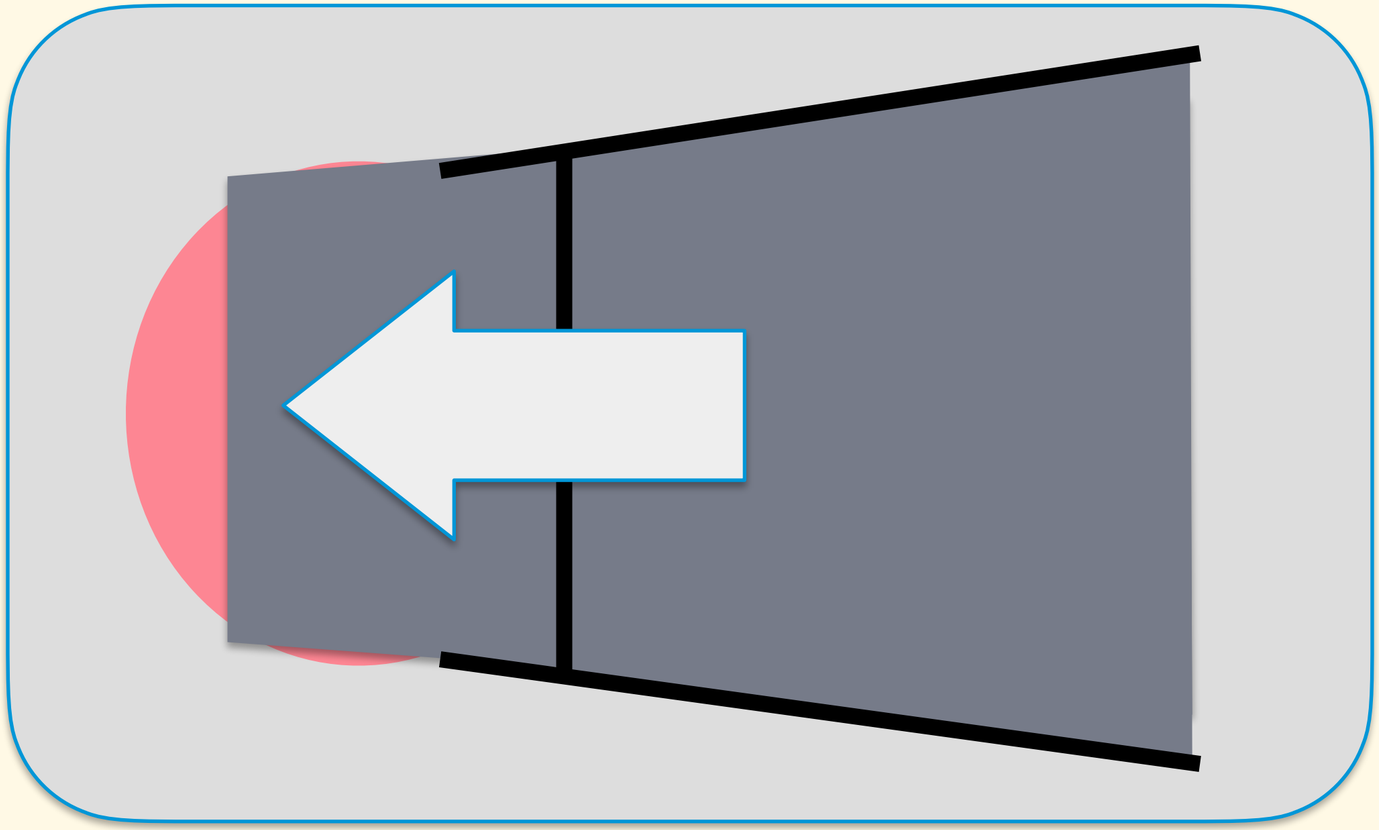
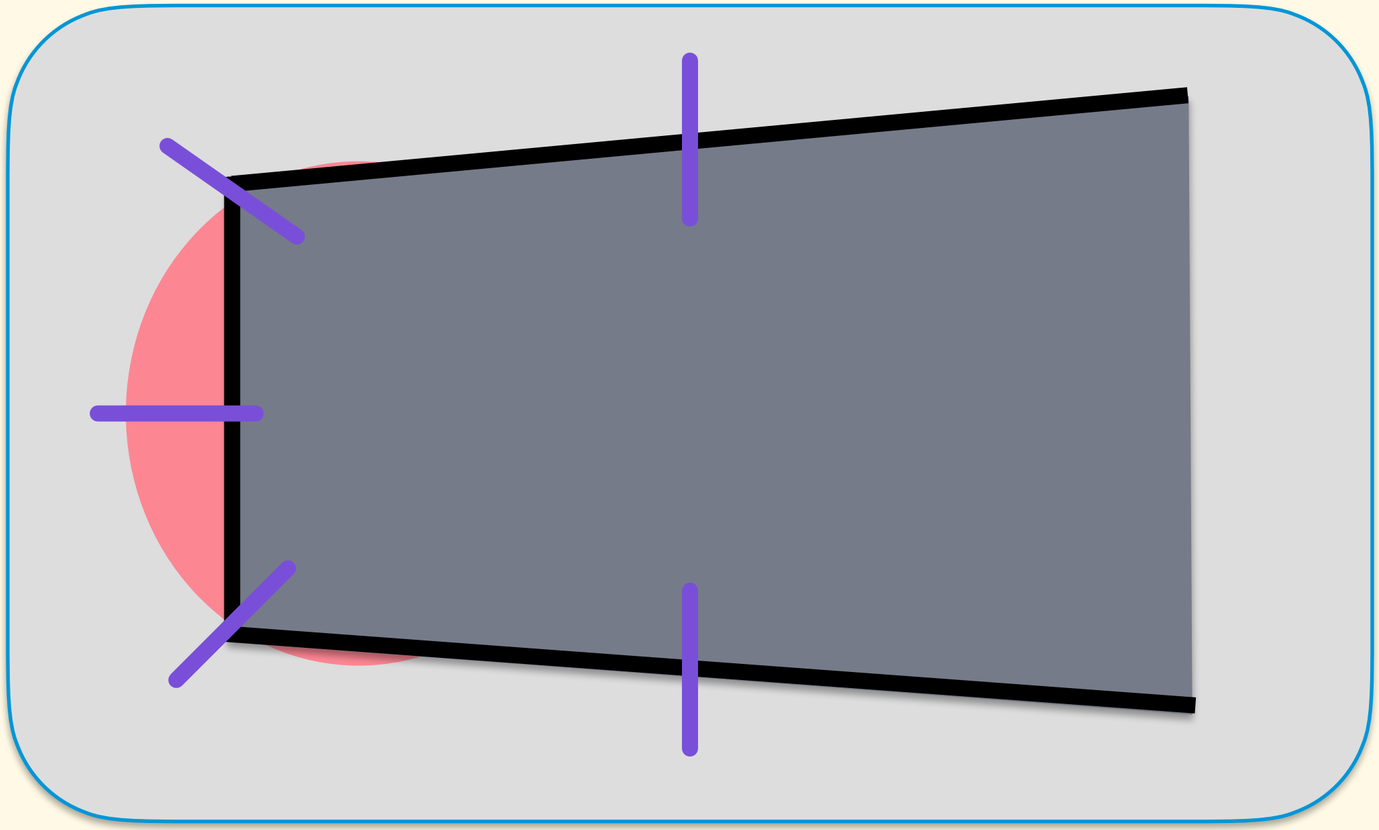


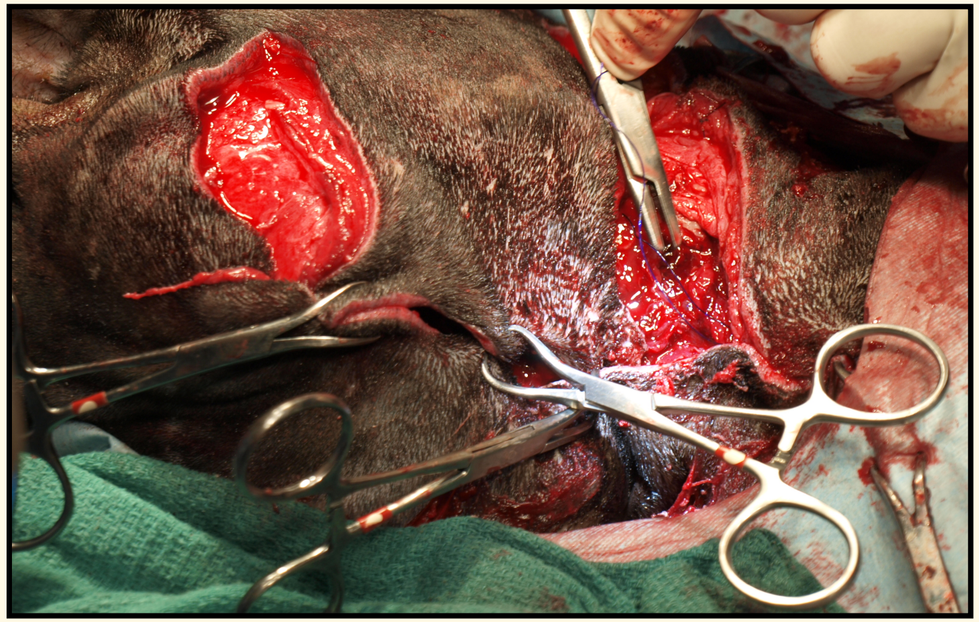
Local Subdermal Flap - Advancement

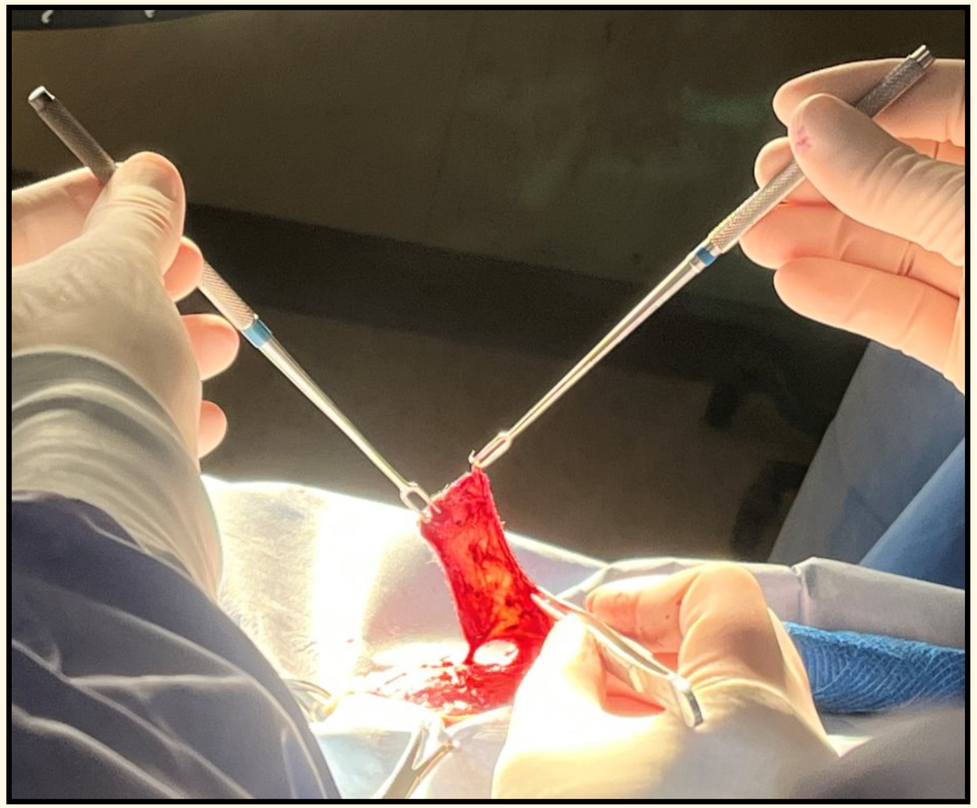
- Closure
  - Subcutaneous tissue
    - 2-0 or 3-0 PDS
    - Simple interrupted Buried knots
      - Corners
      - Halves
    - Goal: Alignment



Local Subdermal Flap - Advancement

- Closure
  - Flap handling
    - Skin hooks
    - Suture
  - Towel clamps to align and keep in place
  - Replace towel clamps with SQ sutures

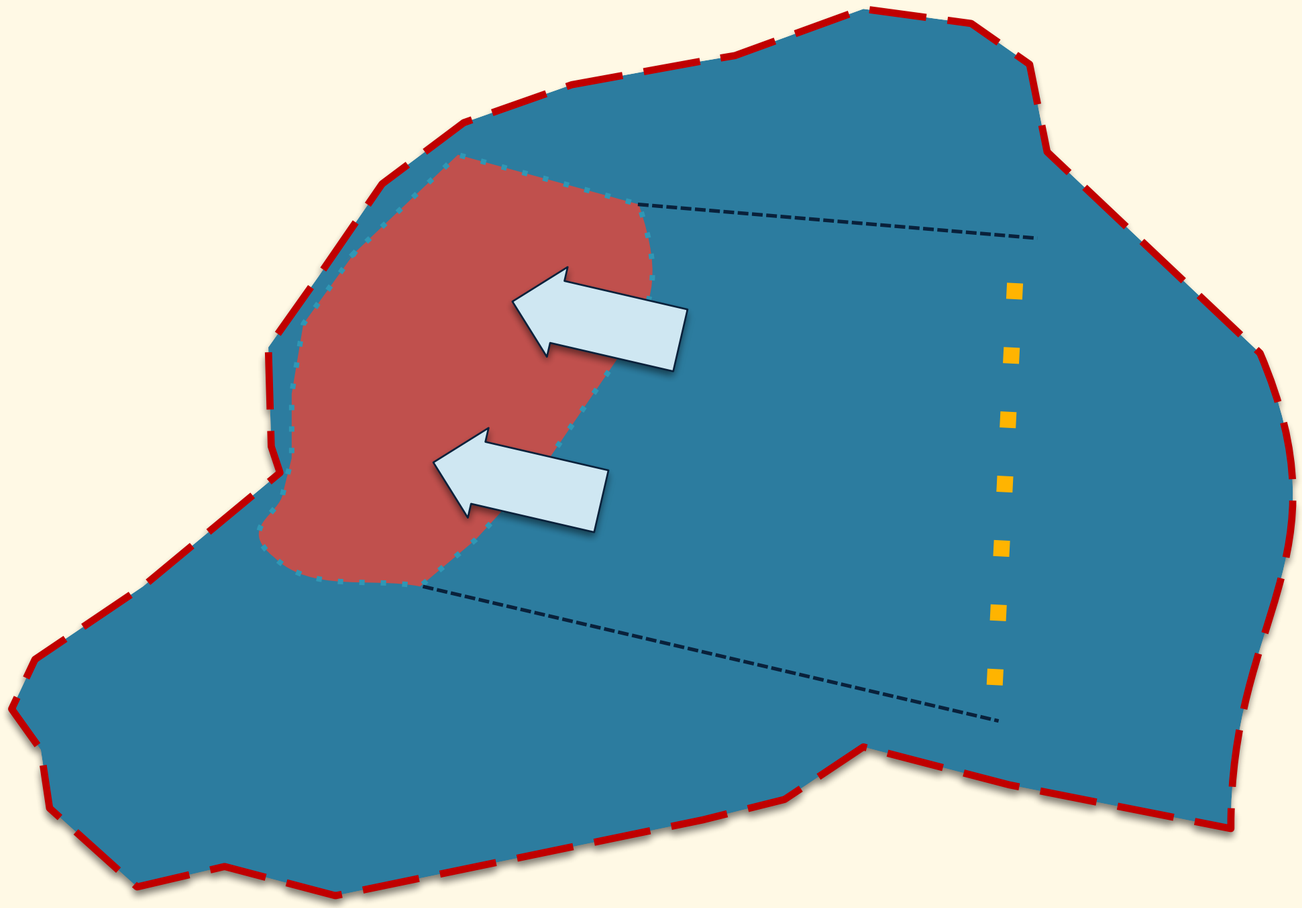


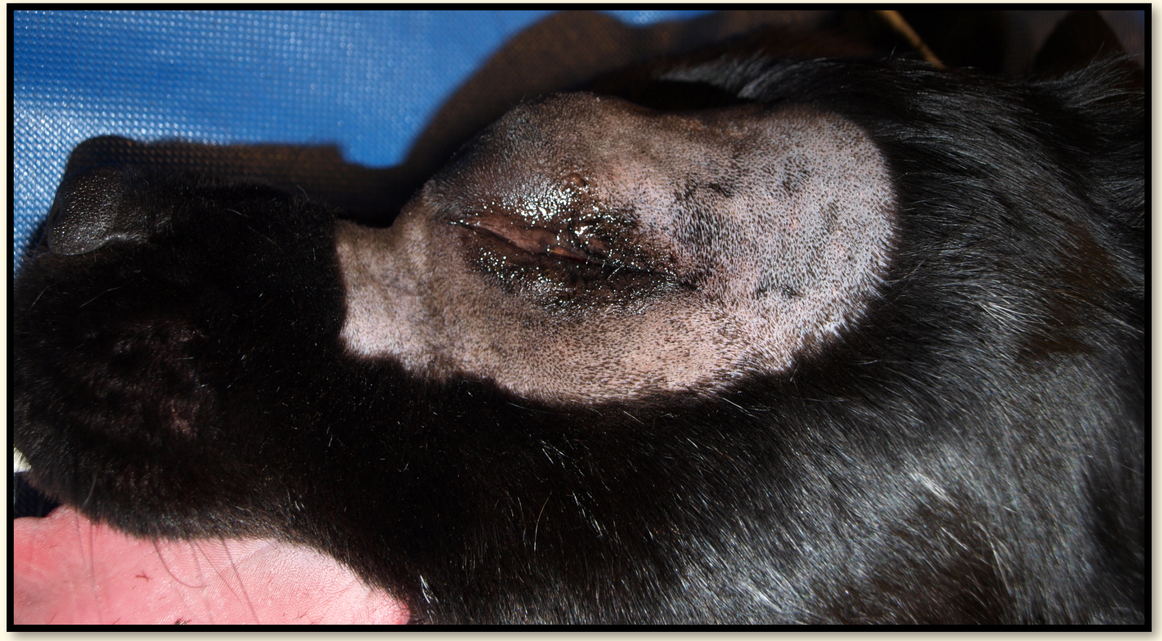


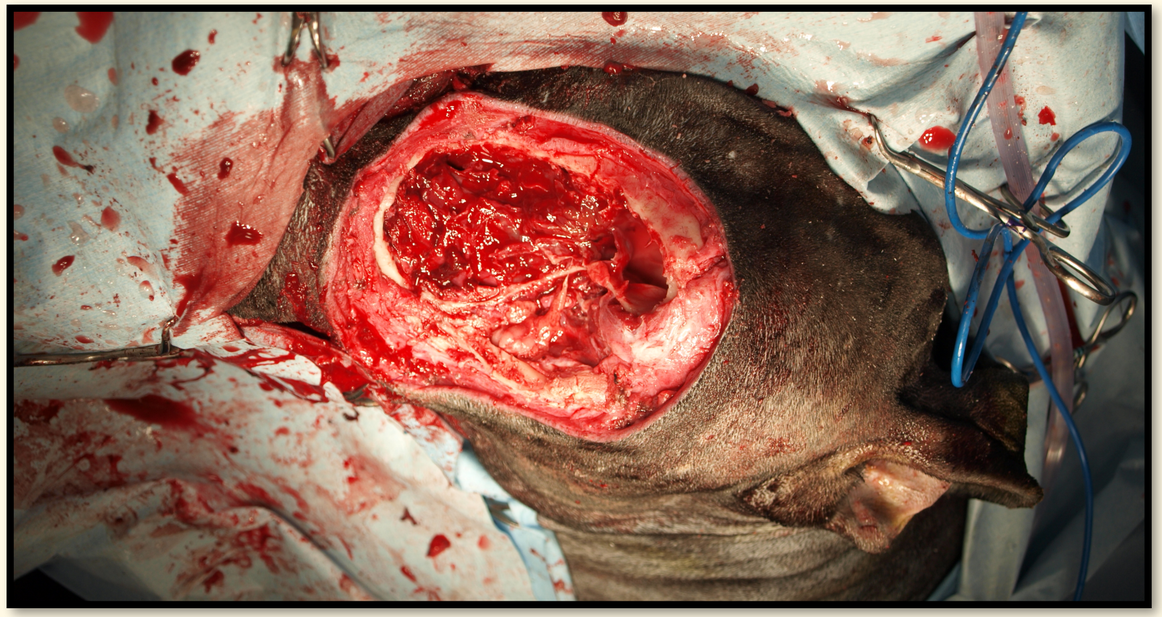
Local Subdermal Flap - Advancement

- Closure
  - Subcutaneous tissue
    - 2-0 or 3-0 PDS
    - Simple continuous
    - Goal: SQ Closure
  - Skin
    - Staples or suture
      - Cruciates

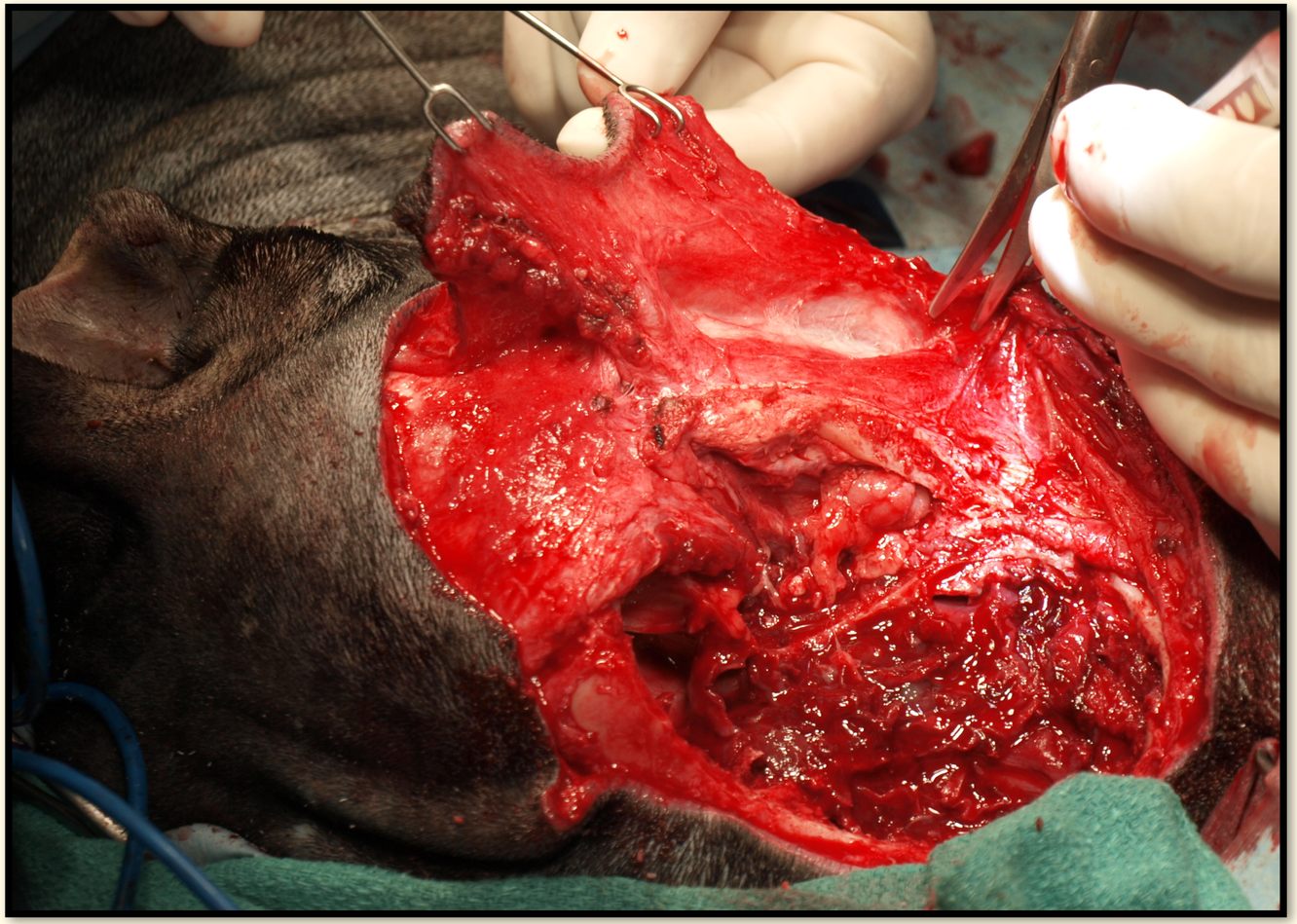
Local Subdermal Flap - Advancement



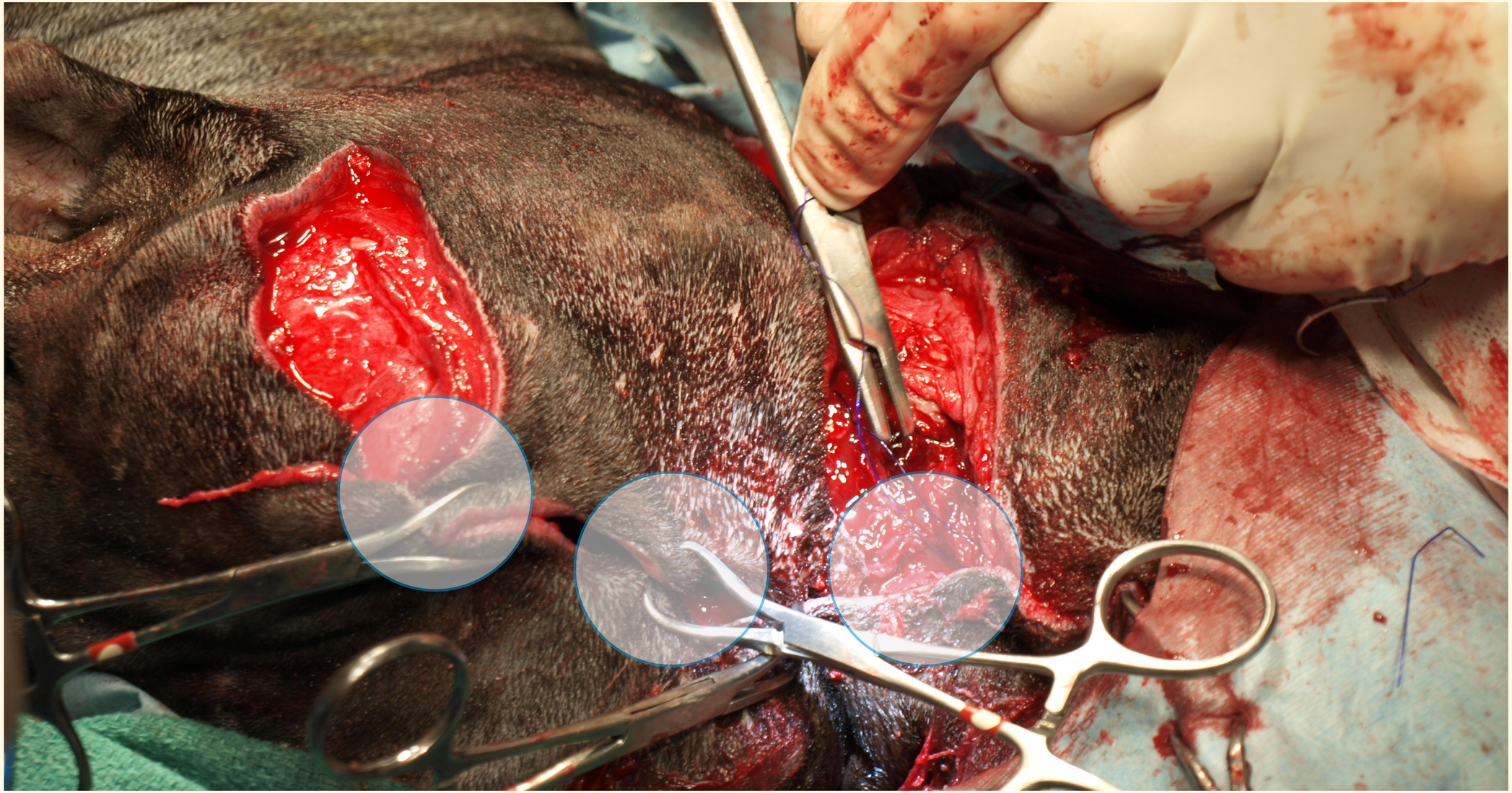




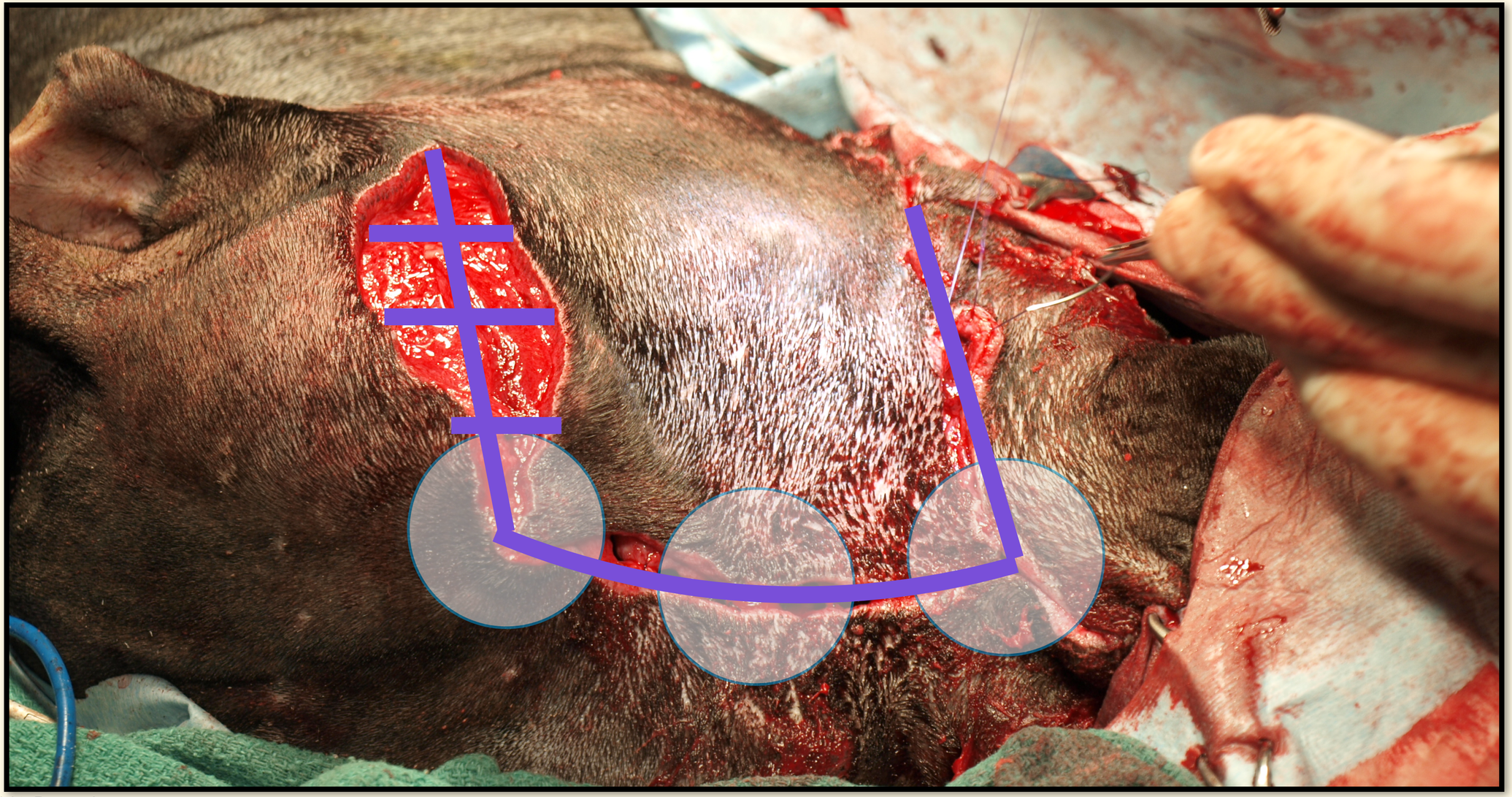
Local Subdermal Flap - Advancement



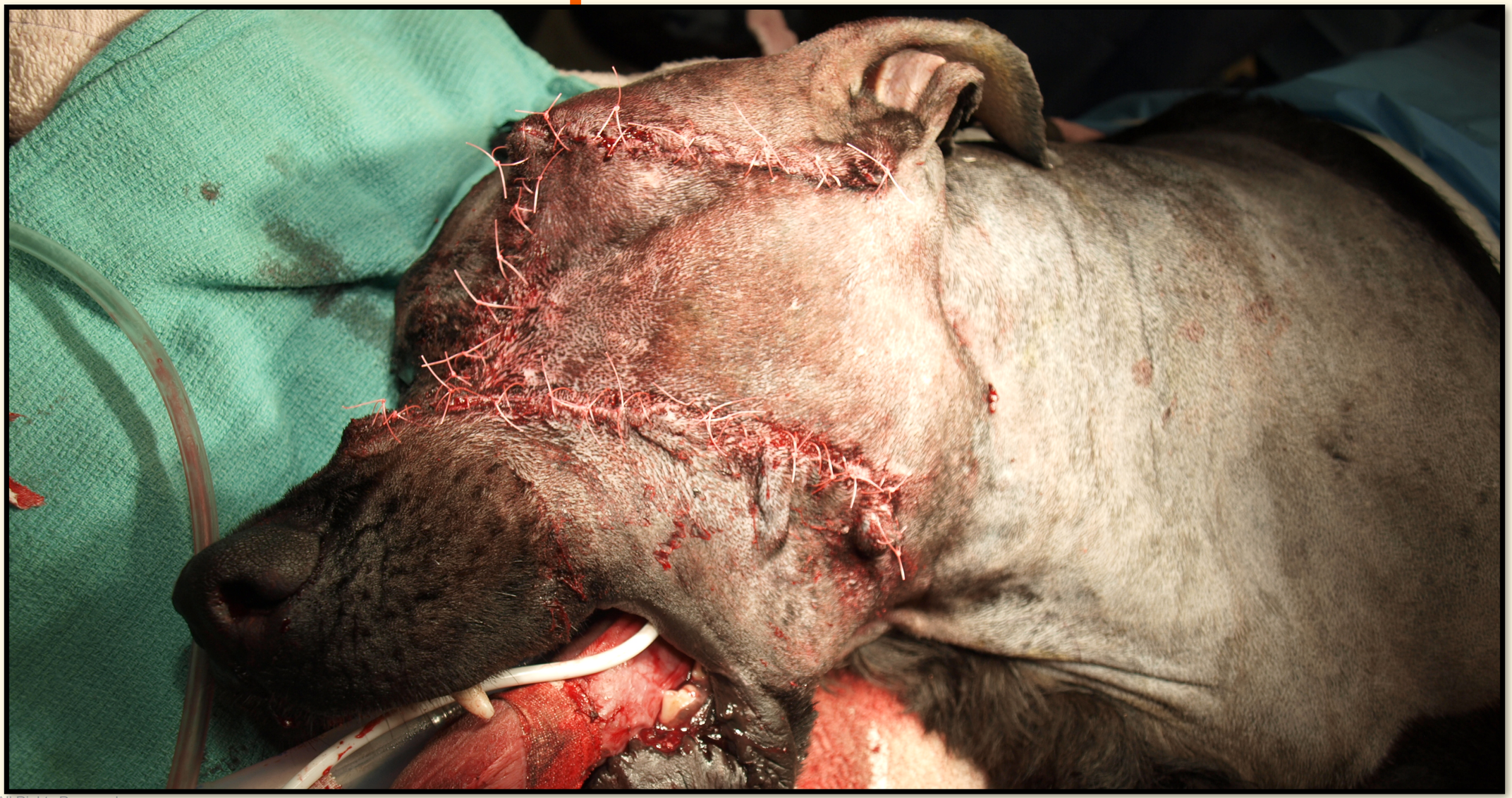
Local Subdermal Flap - Advancement



Local Subdermal Flap - Advancement

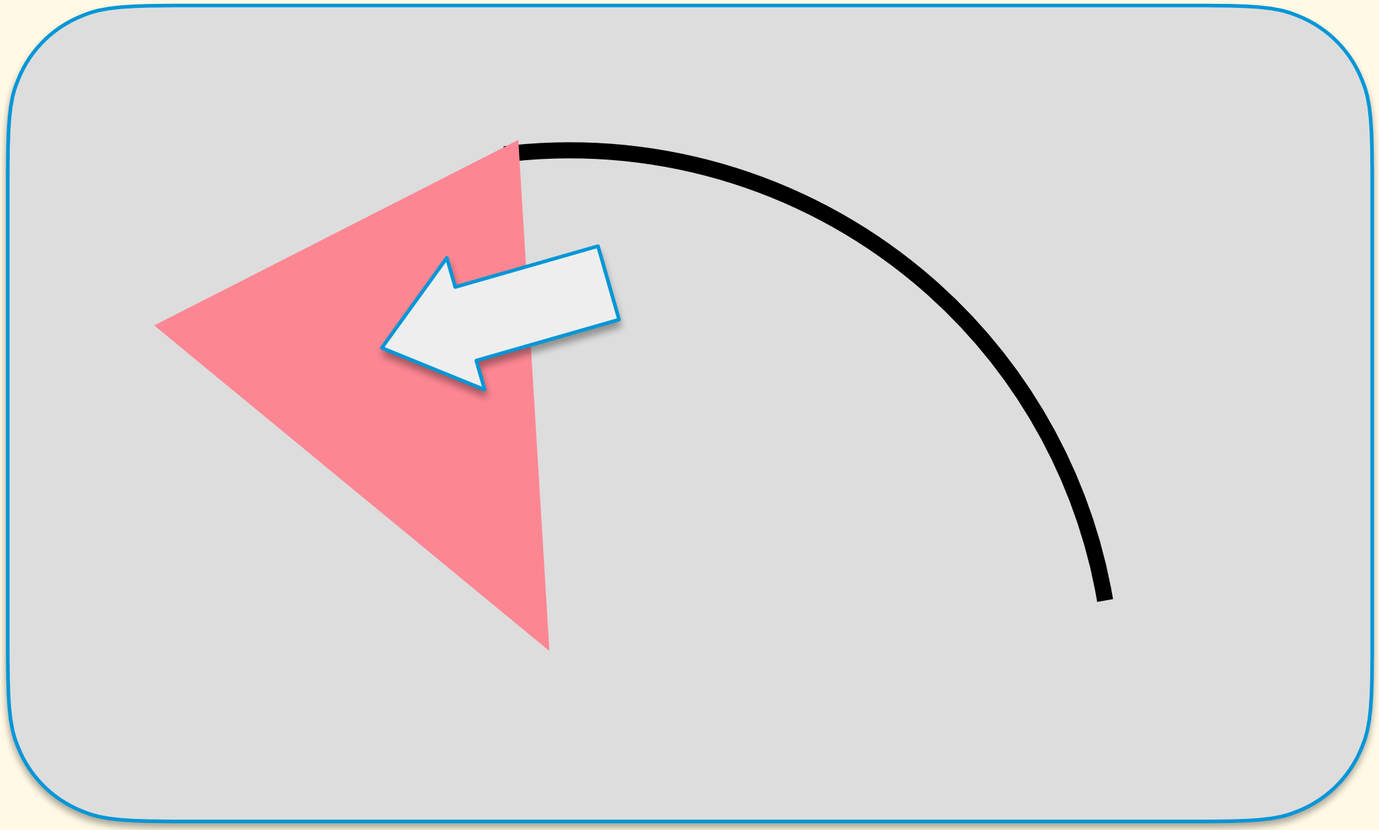


Local Subdermal Flap - Advancement



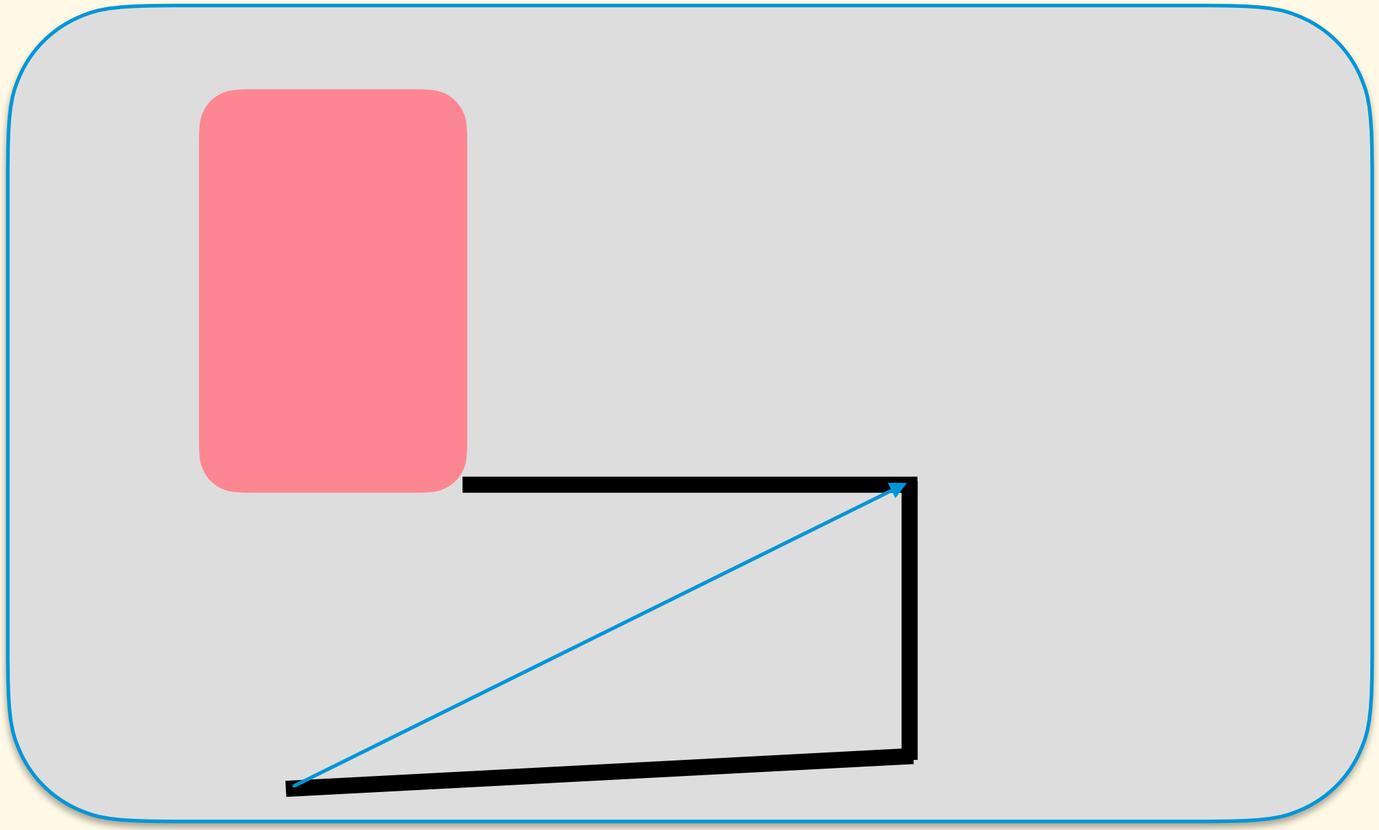
Local Subdermal Flap - Rotation

- Shared border with wound
  - Triangular defect
  - Skin is rotated into wound



Local Subdermal Flap - Transposition

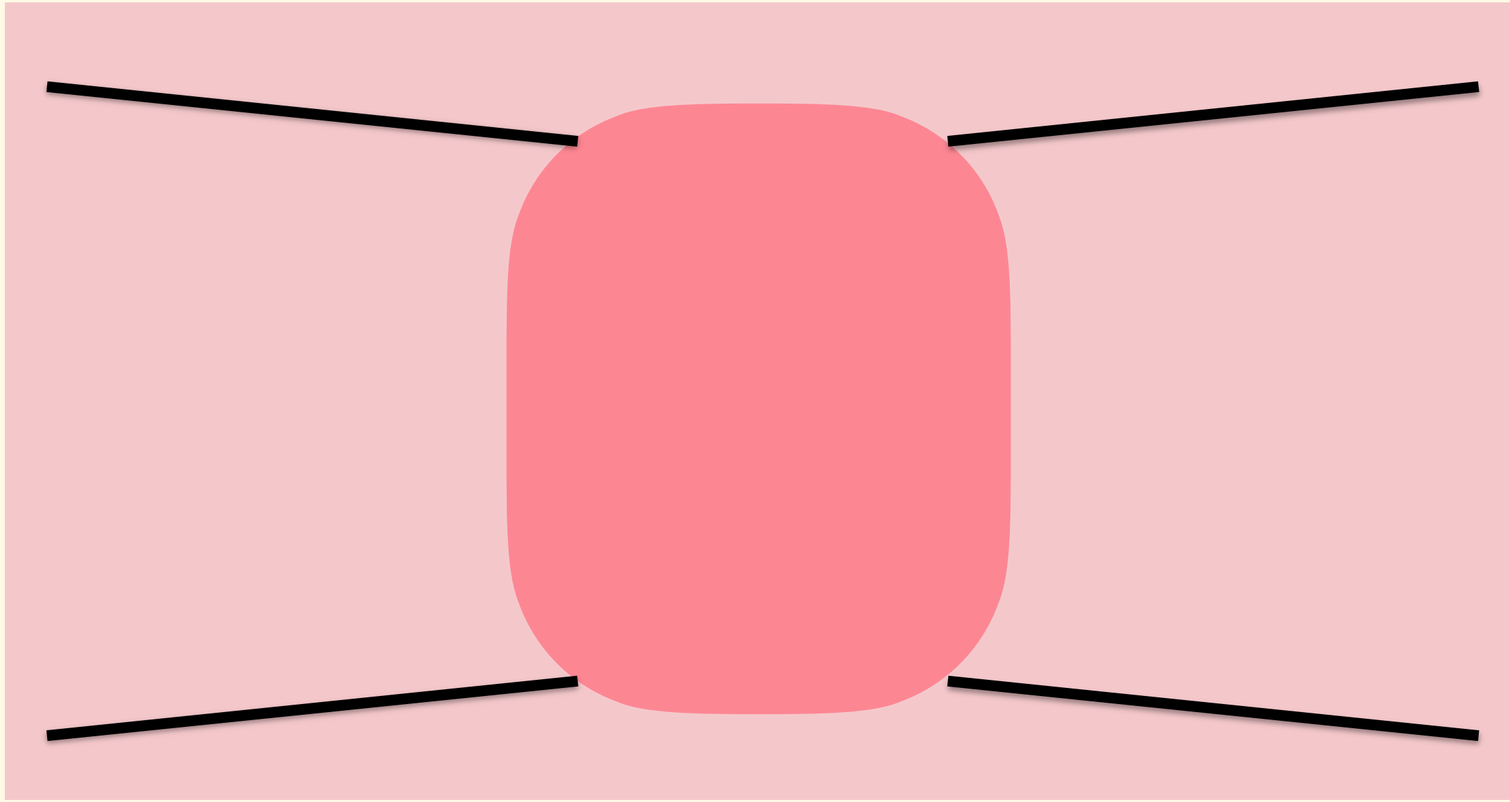
- Shared partial border with wound
- Circular, square defect
- 90 degrees to long axis of defect
- Skin is rotated into wound
- Limbs!



Local Subdermal Flaps

- Can create multiple flaps to cover wound
- Single pedicle advancement flap from opposite sides = H-Plasty

- Think about blood supply
- KISS principle



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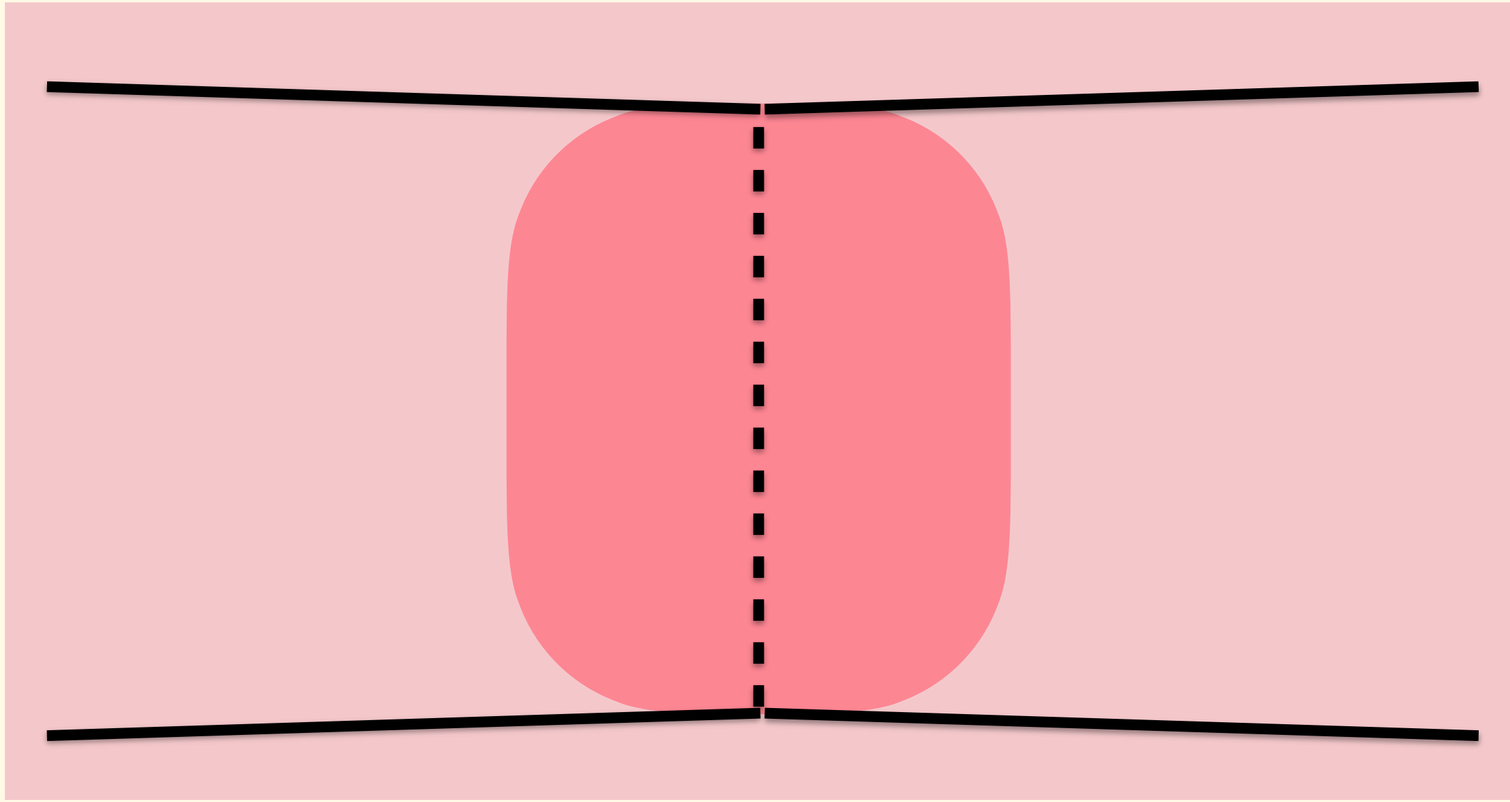


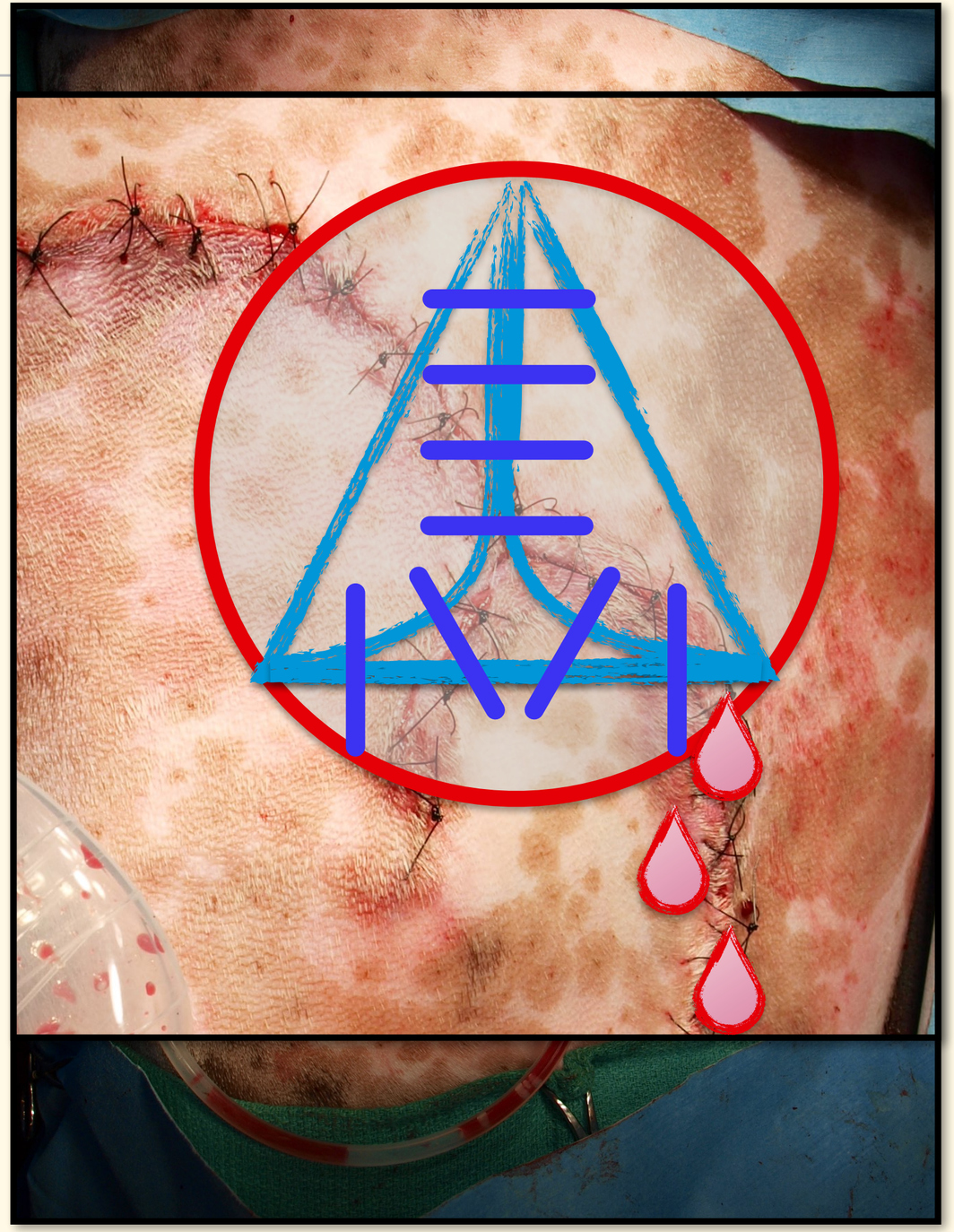
Halstead's Principles

- Aseptic technique
- Gentle tissue handling
- Tension-free closure
- **Eliminate dead space**
  - No tacking sutures on flaps!

- Drains! - Remove fluid, create vacuum

Drain Placement

- Exit away from the incision
- Avoid placing drain under suture line
  - Ok to cross
- Pursestring & Fingertrap

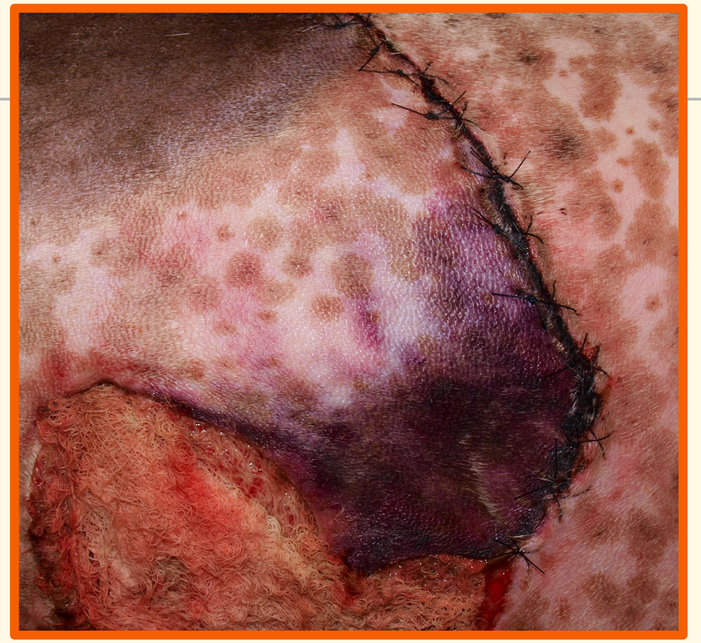


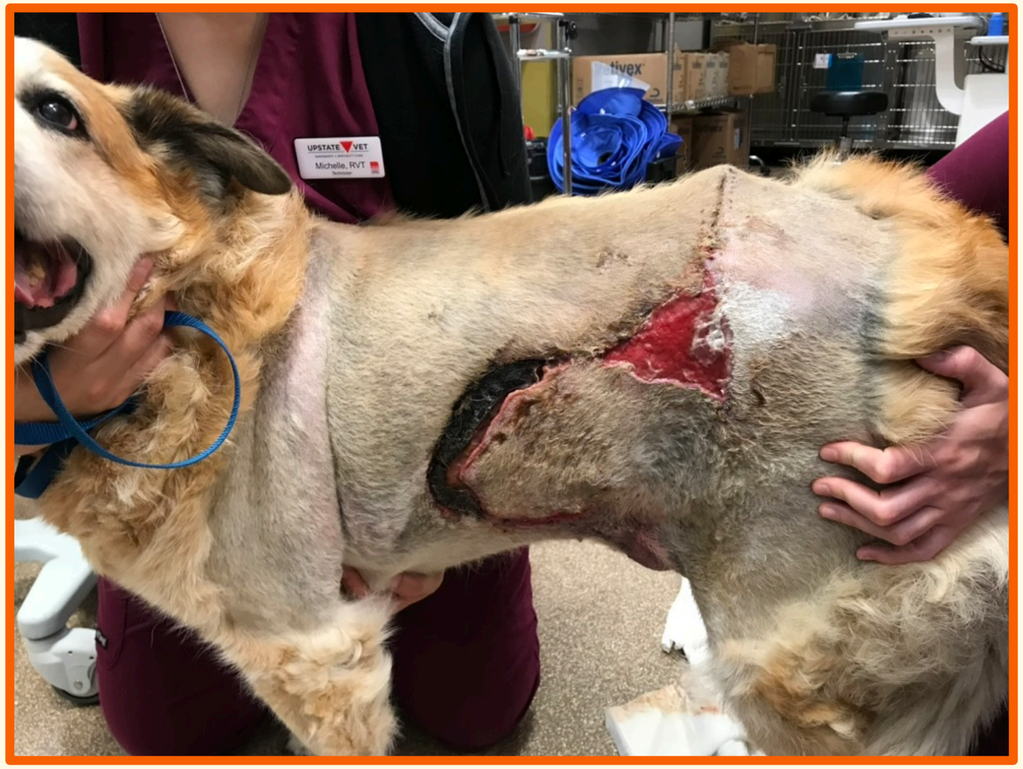
Drain Management

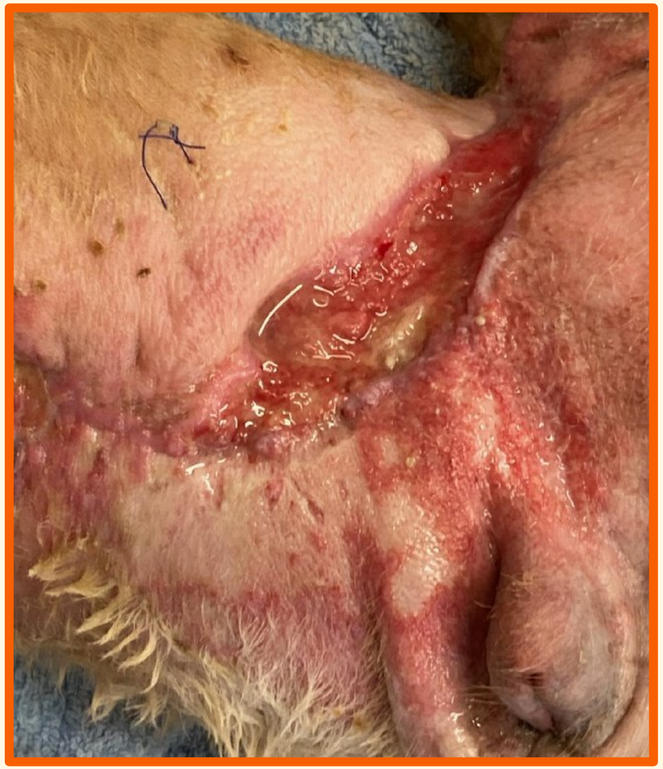
- Empty at least twice daily
- Empty when 1/2 full
- Track production
- Remove when minimal production
- Trends
- Usually 5-10 days
- If it is still producing fluid after 2 weeks, need to figure out why

Flap Complications

- Distal flap necrosis
  - It happens
  - Resuture after declaration
  - Open wound management and 2nd intention healing







Final Thoughts - Closure

- Simpler = Better
- Avoid tension - tight drum = no bueno
- Flap rules are not walk-around knowledge for most - Review prior to case
  - Have Plan A, B, C for large defects - open wound management may be one of them
- Robust flaps are better - keep the panniculus and platysma
- Get comfortable with partial failure - distal flap necrosis

Questions?