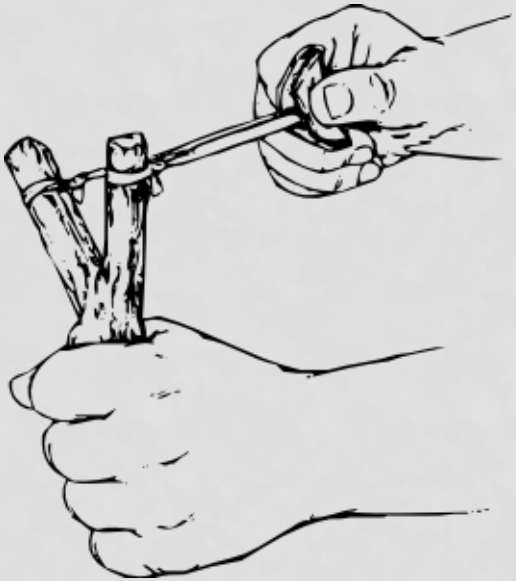


PROJECTILE WOUNDS

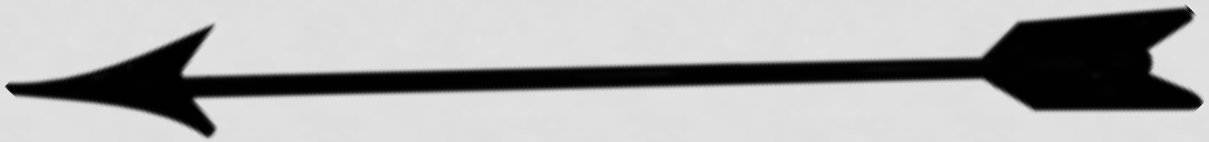
JODIE GERDIN DVM DACVP AUSTRALIA 2018

PROJECTILE NX GOALS

1. ID **entrance & exit** wounds
2. Recover the **projectile** (if present)
3. Document the **extent of the injury**
4. Determine **direction of fire** (position of shooter)
5. Determine the **type of weapon**
6. Determine **range** (*Firearms only*)

PROJECTILE WOUNDS

- **Ranged weapon** = one that hit targets from a distance
- **Projectile** =an object propelled by a ranged weapon
  - Bows & arrows
  - Air guns (aka pellet guns, BB guns) & pellets or BBs
  - Handguns & bullets
  - Rifles & bullets
  - Shotguns & shot
- Projectile wounds share common features because of their shared mechanism:
  Body penetration by a small, fast-moving object



PROJECTILE WOUNDS

- Wounds reflect
  - **Position of the shooter** relative to the target
  - **Type of weapon & projectile used**
  - **Range** from which it was fired (***Firearms only)***
- Penetrating V. Perforating
  - **Penetrating**: Projectile does ***not* exit** the body
  - **Perforating**: Projectile passes **thru** the body

PROJECTILE WOUNDS

- Kinetic energy (KE) of a projectile is determined by its **weight & velocity**
- As a projectile moves through tissue, it makes a ***temporary cavity–*** a zone of tissue compression & tension expanding radially outward from the
- Temporary cavity exists only for a few milliseconds

PROJECTILE WOUNDS

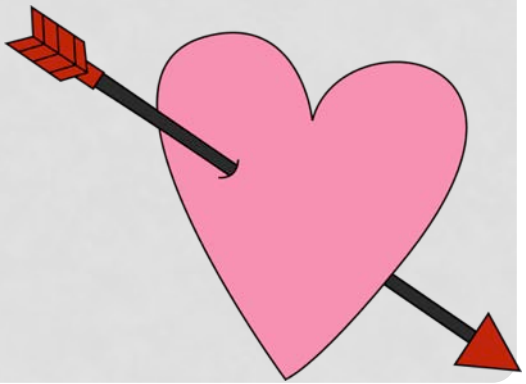
- Size & shape of temp cavity depends on
  - **Projectile** - KE & Rate of KE loss in tissue
    - Depends on projectile shape, angle of impact, & projectile deformation
  - **Tissue** - elasticity & cohesiveness
    - Highly **elastic, cohesive tissue** absorbs KE → **less damage** (ex: skeletal muscle)
    - **Rigid tissue → more damage:** splinter, fracture, or disintegrate (ex: liver, bone)

PROJECTILE TRAJECTORY / POSITION OF SHOOTER

- Determined using:
  - Discriminating **Entrance wound features** (if any)

  –AND--
  - **Initial wound path**

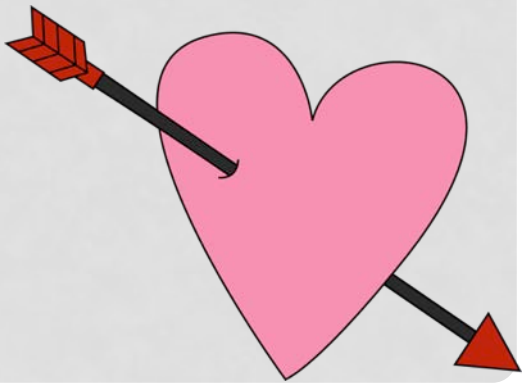
  --OR—
  - **Entire wound path; Entry → Exit** (if ~straight line)
- Assume animal in a standing position
  - Other positions are very possible
- **Note direction in 3D** (3 planes):
  - Right-Left
  - Front- Back
  - Up-Down



PROJECTILE TRAJECTORY / POSITION OF SHOOTER

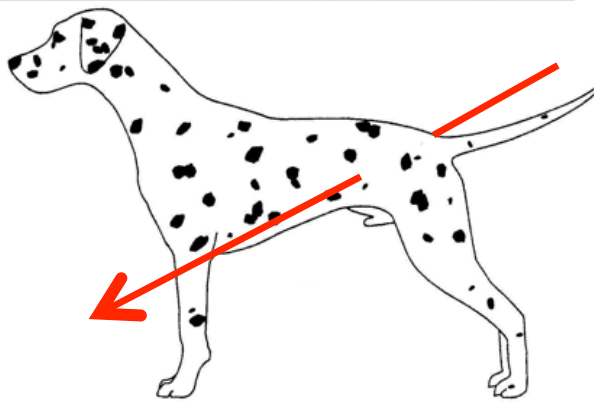
Example:

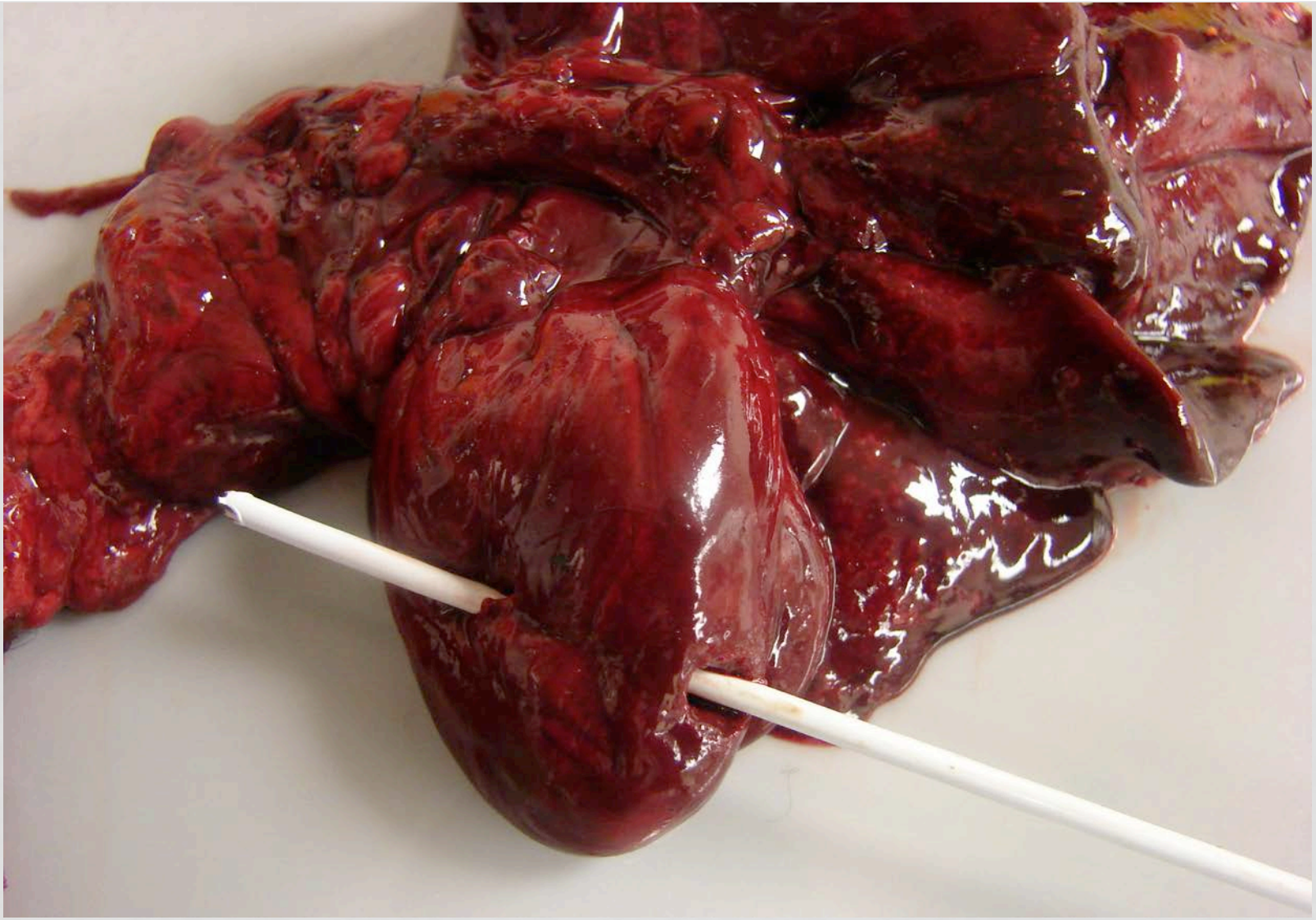
- "**The direction of the wound path is left to right, front to back, and downward** (assuming the victim was standing)."



PROJECTILE TRAJECTORY

- Importance
  - **Used confirm/ refute witnesses statements**
  - If you are presented with X scenario, you can determine if the scenario is ***consistent*** or ***inconsistent*** with the Nx findings
    - Example: "He was about to bite me"
      Was the dog shot from the front?





Cat, shot with air gun.
Path of pellet through heart, delineated using a plastic rod (culture swab w/ tip removed).

ARROWS

ARROW WOUNDS

- The **kinetic energy (KE) of the arrow** & the type of arrowhead, determine the wound severity
- The bow largely determines KE
- Arrowhead determines wound shape +/-penetration
- Arrow wounds range from focal BFT, to linear punctures, to large, cavitated wounds with fractures

3 ARROWHEAD TYPES

- **Target** (Practice & small game)- **clean penetrating**
- **Blunt** (Practice & small game)- **non-penetrating**
- **Broad** (Hunting- large game)- **messy penetrating**

TARGET ARROW HEADS

- Designed to penetrate without causing a lot of damage to target, & easy to remove
- Puncture wound with little surrounding tissue damage

TARGET ARROW WOUNDS

Entrance Wound

- Round to oval **puncture**
- +/- **Abrasion ring**
  due to friction
  abrasion of skin
  by arrow tip & shaft

BROADHEAD (HUNTING)

- Sharp heads, **primarily SF wound**, & varying degrees of associated BF wounds
- Severe tissue damage→ Rapid death
  - Hunters want 1 hit to have maximum effect
  - Rapidity dependent on organs hit
- 2, 3, or 4 blades

BROADHEAD (HUNTING)

Wounds

- **I**, **Y**, or **X-**shaped (2, 3, or 4 blades)
- Skin & hair @ entrance will be ***cleanly cut***
  - Arrows slice tissue, hair
  - Bullets do not
  - Arrows stuck into bullet wounds PM will not cut hair
- Few if any BF features
- Can cut or Fx bone

Deer. Linear (slit) arrow wound made by broadhead tip, with cleanly cut skin & hairs at the margins.

http://www.thehighroad.us/showthread.php?t=414306

Deer. Linear (slit) arrow wound made by broadhead tip, with cleanly cut skin & hairs at the margins.

Deer. Linear (slit) arrow wound made by broadhead tip, with cleanly cut skin & hairs at the margins.

FIREARMS

JODIE GERDIN DVM DACVP AUSTRALIA 2018

NOTE: Entire books are devoted to interpreting firearm wounds in people. The following is extremely condensed, and there is a dearth of literature regarding animals.

FIREARMS

- **Firearms** shoot one or more projectiles using explosive material (**gunpowder**)
- Small firearm wounds most common:
  - **Handguns**
  - **Rifles**
  - **Shotguns**

SMALL FIREARMS

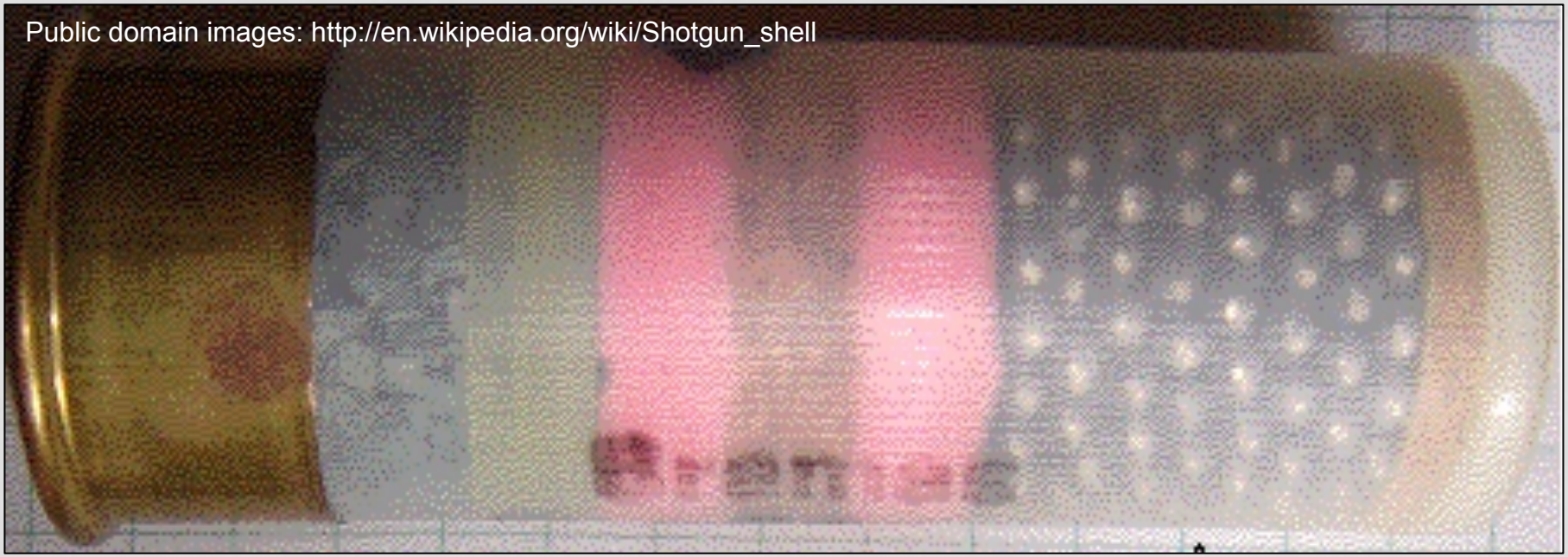
- **Handguns**
  - Short-barreled **rifled** guns, fired in one hand
  - Generally low-velocity, low-energy weapon
  - Fire a single bullet when the trigger is pulled
- **Rifles**
  - Long-barreled **rifled** guns, fired from the shoulder
  - Accurate over a long range
  - Generally a high-velocity, high-energy weapon
  - Fire a single bullet when the trigger is pulled
- **Shot guns**
  - Designed to be fired from the shoulder
  - Long-barreled smooth-bore (***non-rifled***)
  - Fires small spherical pellets (**shot)**, OR a single solid projectile (**slug**)
  - Shot loses its kinetic energy very quickly

RIFLING

- Grooves in the barrel make a projectile spin
  - Spin stabilizes bullet trajectory, increases accuracy
- Rifling leaves marks on projectile, which can be matched to an individual weapon ***if you have the weapon***
- Weapons without rifling ***cannot*** be matched to their projectiles
  - Ex: Most air guns, Shotguns

PROJECTILE SIZE

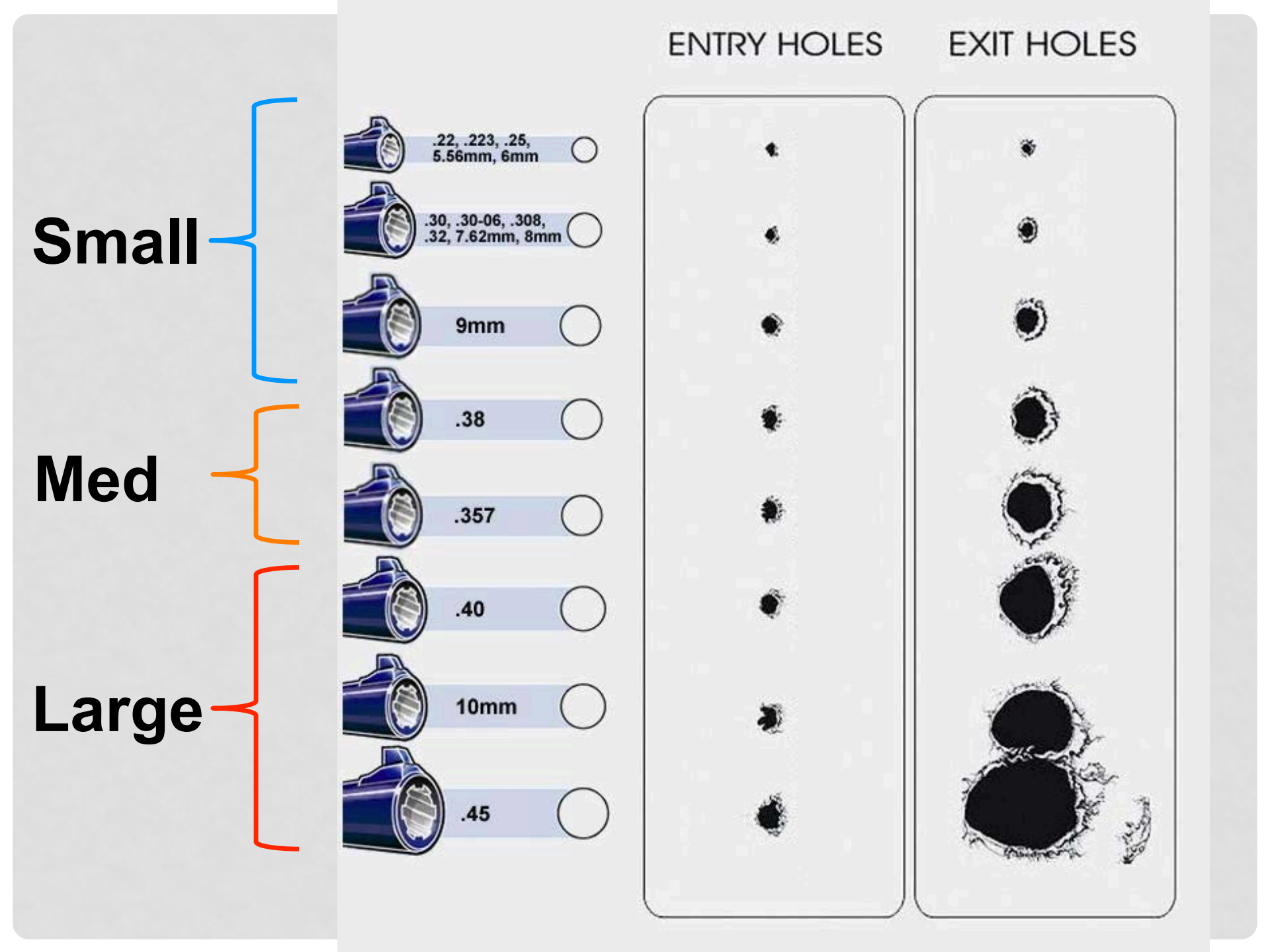
- The size of a weapon is determined by the size (**caliber**) of its bullets, ***except shotguns***.
  - A 38 caliber gun fires a 0.38" diameter bullet
  - A 9 millimeter handgun fires a 9mm diameter bullet
- ***Shotguns*** are classified by gauge.
  - **Gauge** = the # of lead balls with the same diameter as the barrel that would be needed to equal 1 lb.
  - **Smaller gauge = fewer, bigger balls**
- Modern shotguns are loaded with a ***shell*** a sandwich of gunpowder, shot/ balls, & padding, in plastic case



A 12-gauge shotgun shell in a clear plastic hull, allowing the contents to be seen. From left to right: gunpowder, over-powder wad, shot wad, #8 birdshot, and over-shot wad.

DETERMINING PROJECTILE SIZE

- ***Measure the projectile***
  - Document projectiles **diameter & shape** (measure, record & photo)
- If no projectile, wound size can be used to ***estimate***
  - Wounds are usually much **larger** than projectile
  - Likely caliber described as:
    - **Small** (.22, .25)
    - **Medium** (.32, .38, 9 mm)
    - or **Large** (.40, .45, .50)


ENTRY HOLES
EXIT HOLES
Small
Med
Large
.22, .223, .25, 5.56mm, 6mm
.30, .30-06, .308, .32, 7.62mm, 8mm
9mm
.38
.357
.40
10mm
.45

FIREARM WOUNDS

- Low-velocity **Handgun** = ***small* temporary cavity**
  - Injuries are limited to what the bullet strikes directly
- High-velocity **Rifle** = ***large* temporary cavity,** with a significant effect on final wound
  - Surrounding tissue (inc. bone) may be injured, even ***outside* of the obvious bullet path**

.40 caliber - Pistol

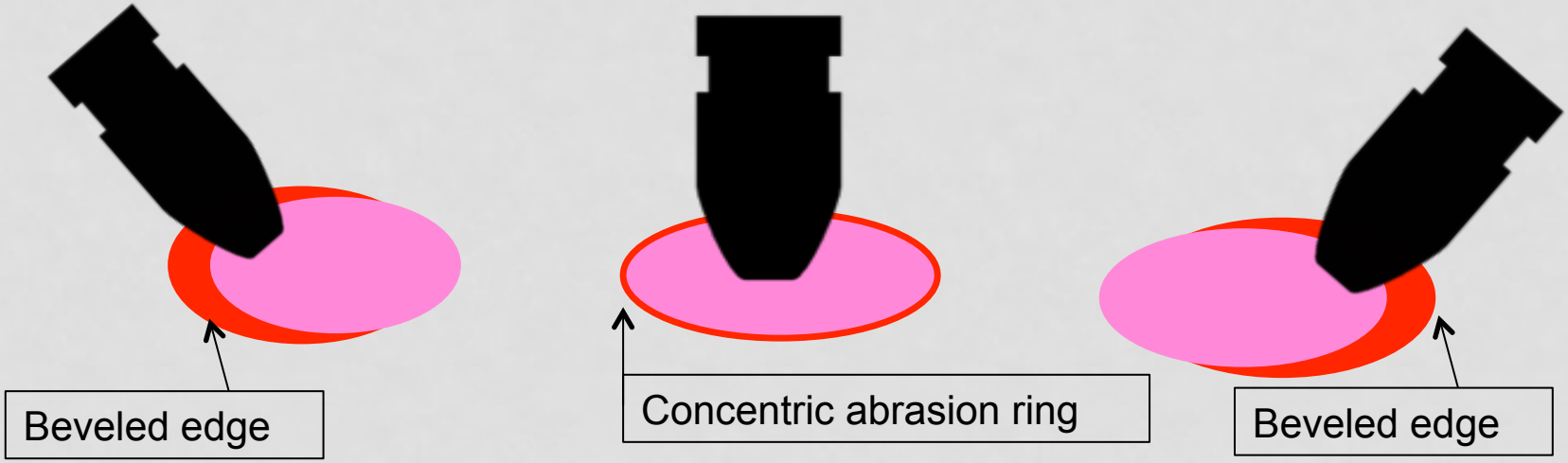
ENTRANCE WOUNDS

- Wound margins cannot be re-approximated
  - b/c skin is gone (~vaporized)
- "Punched out" circular to oval skin defect*
- **Abrasion ring**
  - Pathognomonic for entry*
  - Exit wounds ***DO NOT HAVE*** an abrasion ring

*Except atypical entry wounds

ENTRANCE WOUNDS

- When a bullet enters the skin **perpendicularly** → **concentric** margin of abrasion
- When a bullet enters the skin at an **angle**→ **eccentric** margin of abrasion (AKA **beveling**)
  - The thickest aspect of an eccentric margin (the **bevel**) reflects the direction the bullet came from



EXIT WOUNDS

- As bullets pass thru the body
  - Loose energy (KE)
  - Tumble (***yaw***)
  - May become deformed

Tumbling bullet

EXIT WOUNDS

- Any shape
  - Ex: oval, slit, crescent, stellate, & irregular
- ***Lack abrasions***
- Frequently, but not always, larger than entrance
- Tissue often protrudes through the exit wound
- Exit wound margins ***can*** be re-approximated

Tumbling bullet

Entrance wound

- Usually smaller
- Circular defect
- No tissue protrudes
- **Peripheral abrasion**
  - Air guns +/- abrasion ring

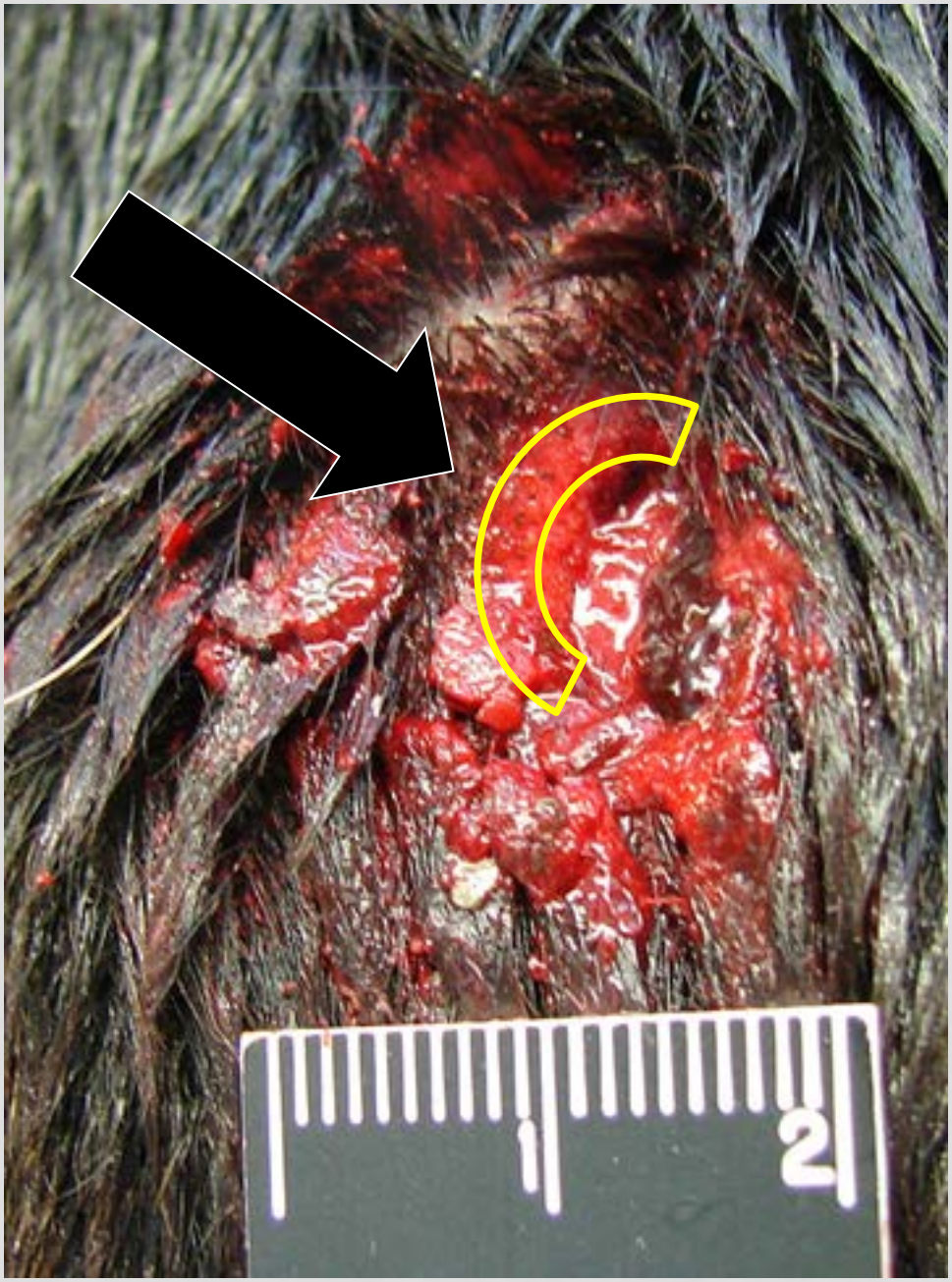
Exit wound

- Usually larger
- Irregular / no shape
- Edges irregular & can be put back together
- **No abrasion**

Entry or Exit wound? Why (features)?

Exit wound. Irregular shape, no abrasion ring, hint of SQ fat protruding thru

Entrance gunshot wound with abrasion ring from 8 to 12 o’clock, consistent with bullet entry above and to the left of the wound.



Entrance gunshot wound with abrasion ring from 8 to 12 o’clock, consistent with bullet entry above and to the left of the wound.

ATYPICAL ENTRANCE WOUNDS

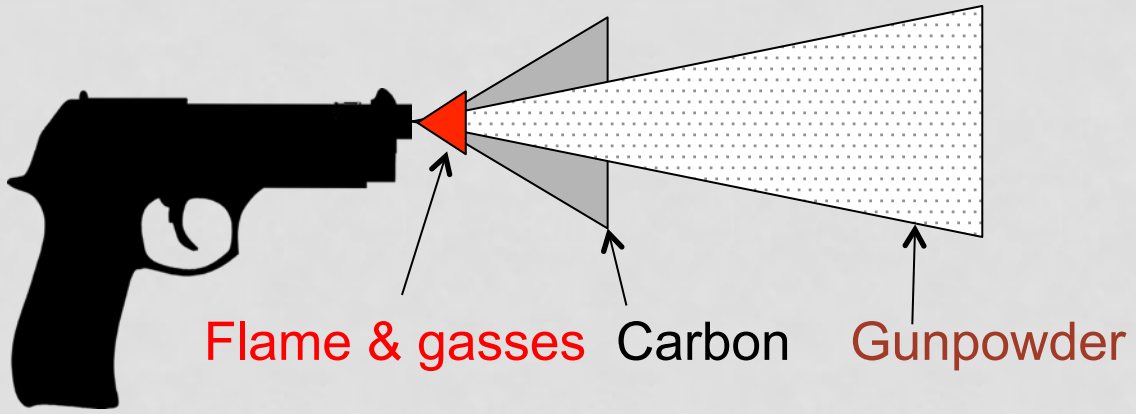
- **Look like exit wounds**
  - Shape irregular, with torn margins
- Occurs with
  - **High-velocity firearms**
    - Rifles w/center fire ammo
  - Bullet is tumbling (**yaw**)
    - **Ricochet** (bullet hit something else before body)
      - Range cannot be determined from a ricochet bullet entrance wound
    - Weapon fired incorrectly / is damaged
    - Defective ammo

Dog. Atypical entrance wound overlying the left cheek, due to the immediately underlying bone (which had a comminuted Fx). Weapon / caliber unknown; bullet perforated the head.

RANGE OF FIRE

A fired bullet is accompanied by:

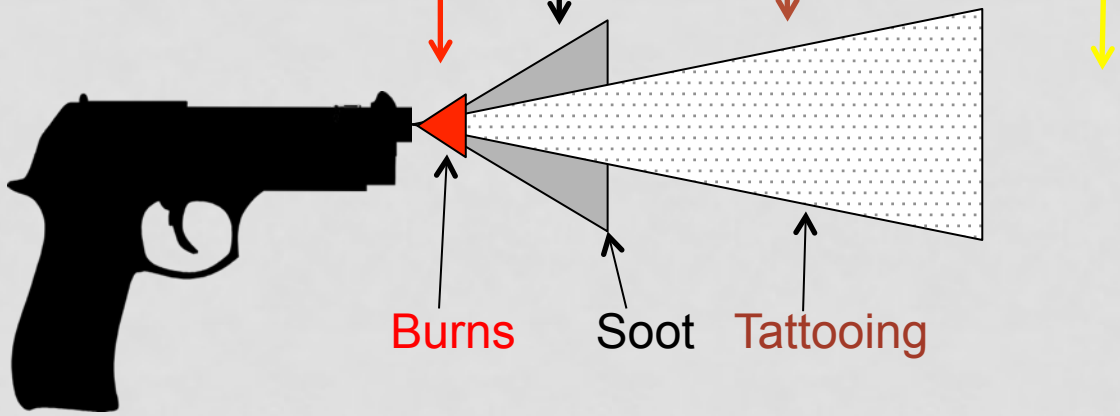
- **Flame & Hot gasses**
  - Sears tissue→ charred (burnt) skin & hair
- **Soot (carbon)**
  - Black -grey smear; Can be wiped away
- **Burnt, burning, & un-burnt gunpowder**
  - Skin stippling ("**tattooing**"); *Cannot be wiped away*



RANGE OF FIRE

- Because of these materials, gunshot wounds *on uncovered human skin* can be categorized into:

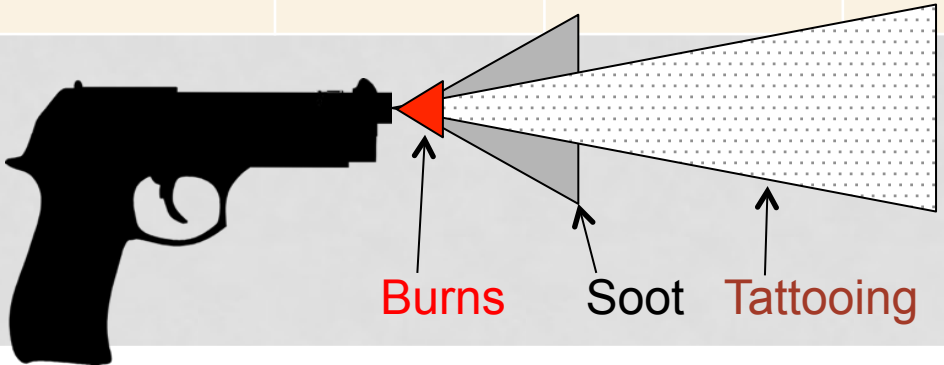
1. **Contact wounds**
2. **Near contact wounds**
3. **Intermediate wounds**
4. **Distant wounds**



Human. Entry wound with soot

Human. Entry wound w/ stippling (tattooing)

	Entrance Wound	Contact	Near Contact	Intermediate	Distant
Flames & hot gas	Char / Burn	**Yes**	No	No	**No**
Soot	Black-grey film	Some, driven into wound	**Yes**	No	**No**
Gunpowder	Pinpoint black spots, does **not** wipe away	Some, driven into wound	**Maybe**	**Yes**	**No**
***Approximate* Range (handgun):**		**0**	**0 - 30 cm**	**30 – 60 cm**	**> 60 cm**



FORENSIC SCIENCE COMMUNICATIONS

April 2004 - Volume 6 - Number 2

Research and Technology

Effect of Hair on the Deposition of Gunshot Residue

Alexander Jason

Gunshots with & without hair.
The hair filters out powder particles & absorbs the majority of the soot.

Also

1" w/o hair

1" w/hair

RANGE OF FIRE: BAD NEWS

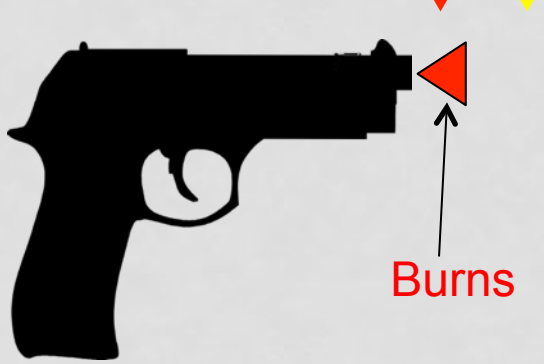
- **Hair can completely prevent the deposition of gunshot residue (soot & gunpowder)**
- In haired areas of animals, an entry wound ***without stippling, soot, or gunshot residue*** is
  - NOT a contact wound
  - But could be either:
    - **Close contact**
    - **Intermediate**
    - **Distant**

RANGE OF FIRE: BAD NEWS

- **Hair can completely prevent the deposition of gunshot residue (soot & gunpowder)**

1. **Contact wounds**

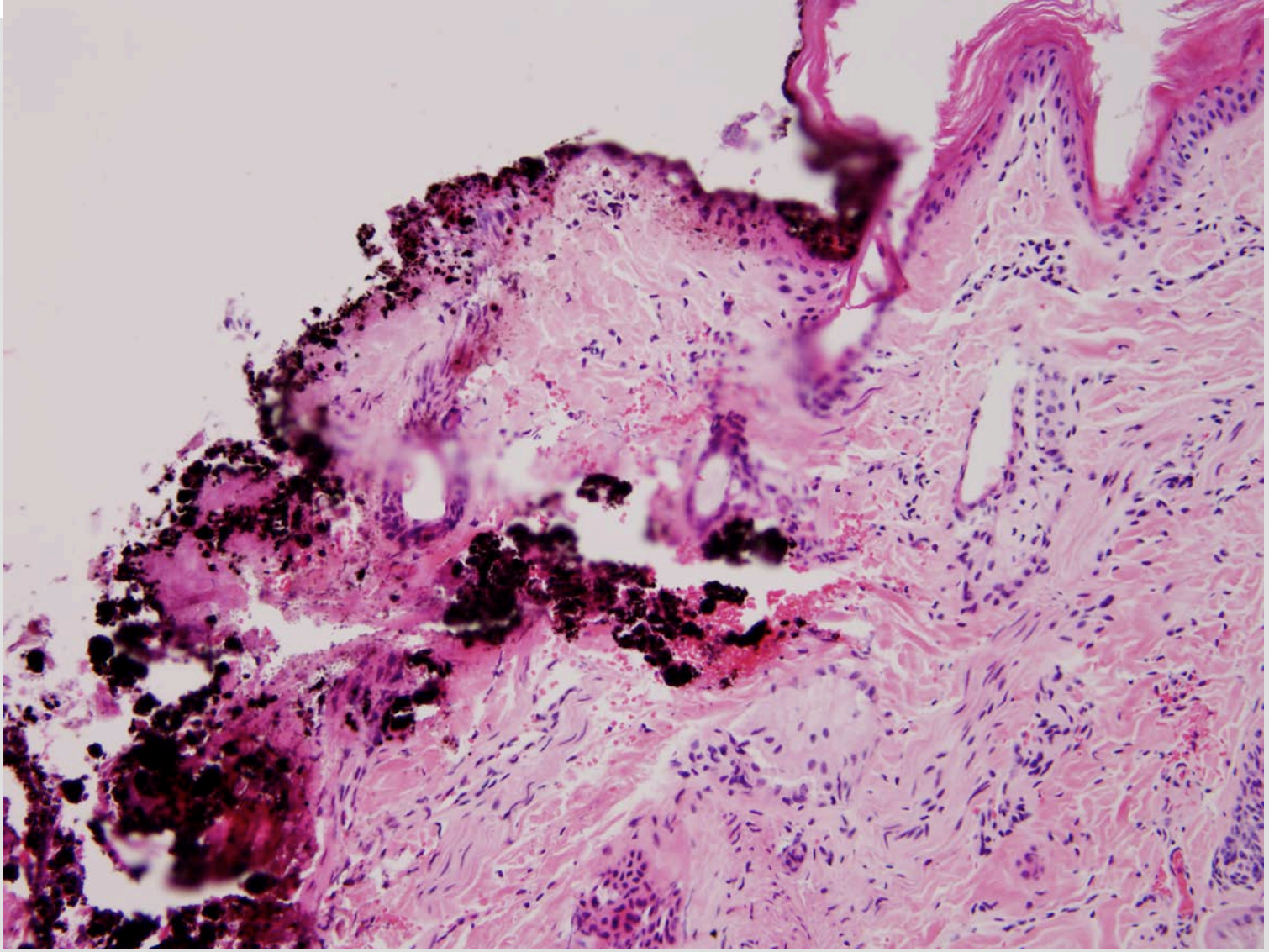
2. **Everything else**



RANGE OF FIRE: "GOOD" NEWS

- Hair retains gunshot residue
- Distance determinations of haired haired areas may be made by lifting gunshot residue particles using double sided tape & submitting for analysis (Zeichner &Levi 1993)

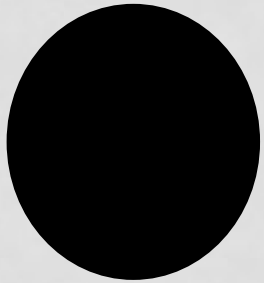
Calf, dorsal skull. Shot (euthanized) with a .22 rifle. This contact entrance wound has seared edges & embedded soot which could not be wiped away.



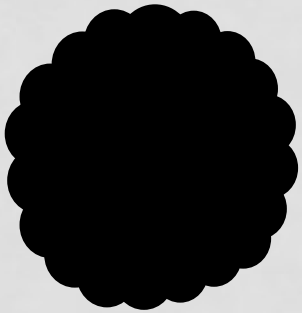
Calf. Histologic section of skin from entrance wound, showing seared edges (coagulated collagen) and embedded soot (brown-black material).

RANGE: SHOTGUN WOUNDS

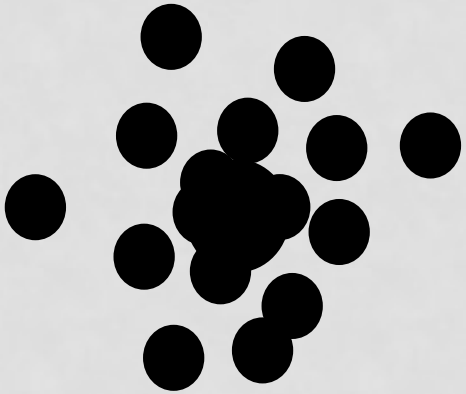
- When shot exits the barrel, it initially travels as a tightly grouped cluster that spreads out over space/ time
- **Range of =/< 1m**
  - the cluster impacts together, makes a round defect
- **Range @ 1m**
  - wound = 1 defect with scalloped margins
- **> 1m**
  - Central defect w/ scattered satellites
- Ultimately, central defect is lost
  - pellets strike skin without overlapping
- Presence of **wadding** in wound indicates **< 4m range**



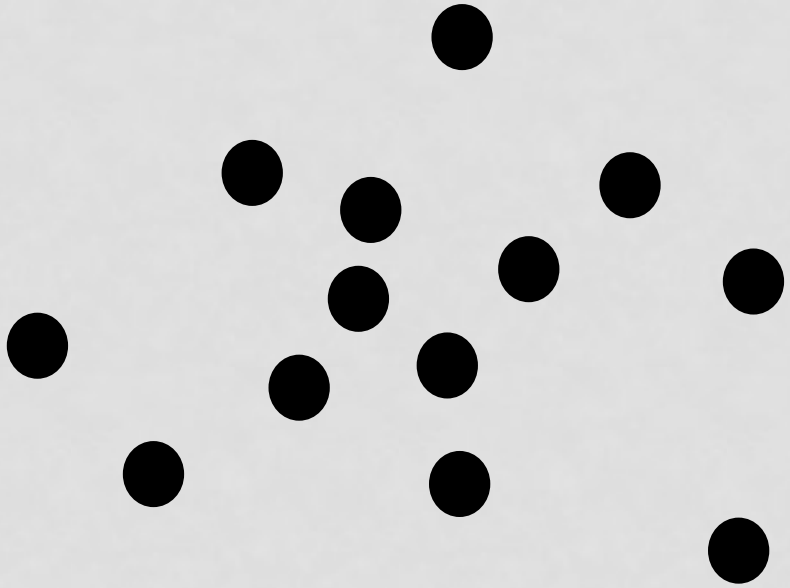
Smooth edge (< 1m)



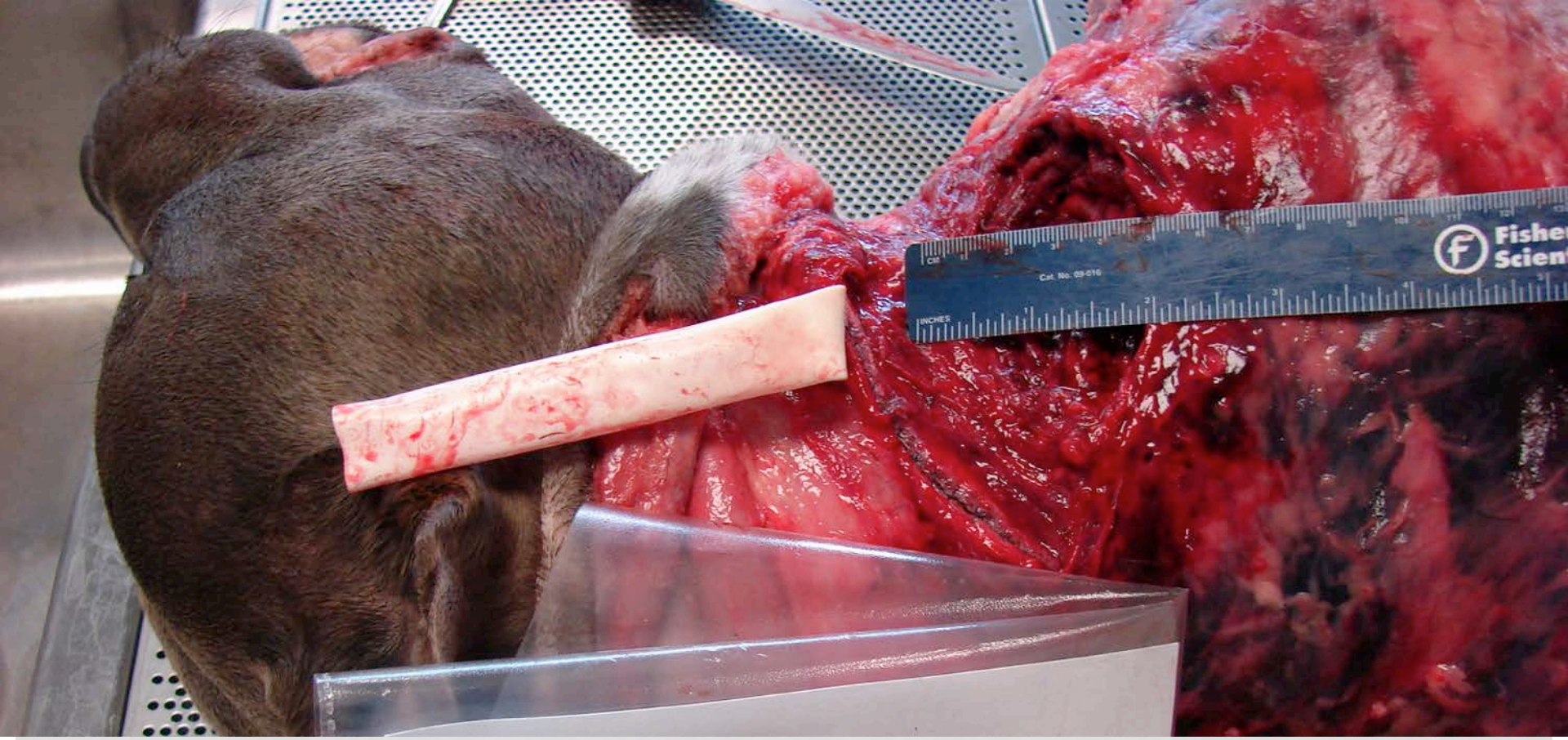
Scalloped edge;
Close range (1m)



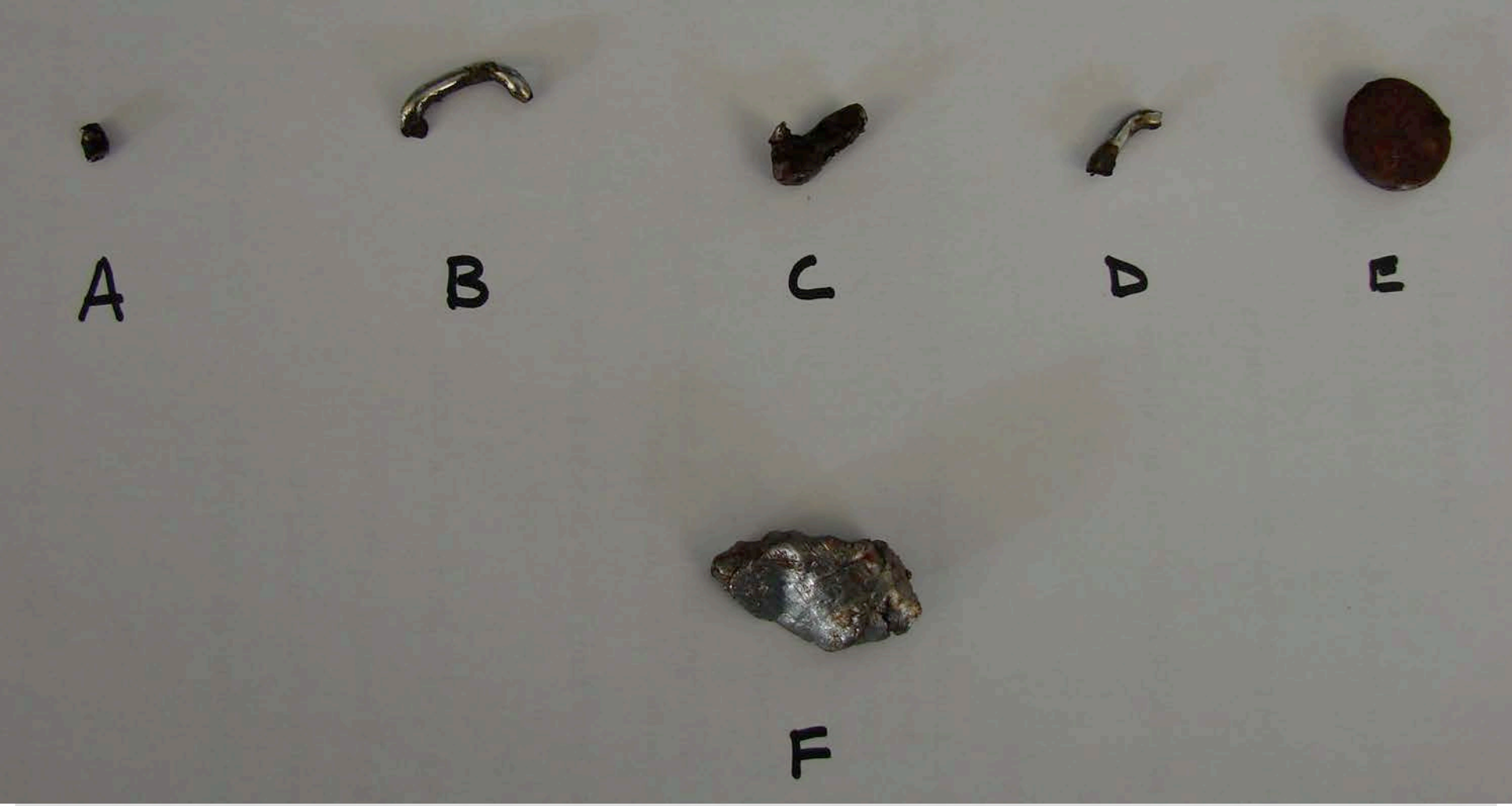
Central defect with scattered satellite pellets (>1m)



No central defect; individualized pellets



Dog. Large (~4cm diameter) close-range (<4m) crater-like shot gun wound with single 20g slug to the right shoulder.
(Suboptimal Photo: Wound obscured by ruler!)



Material retrieved from the shotgun wound of the dog in previous image, including the slug (F) and wadding (E). Dog was wearing a metal chain collar when shot. Wadding indicates the range was <4 m.

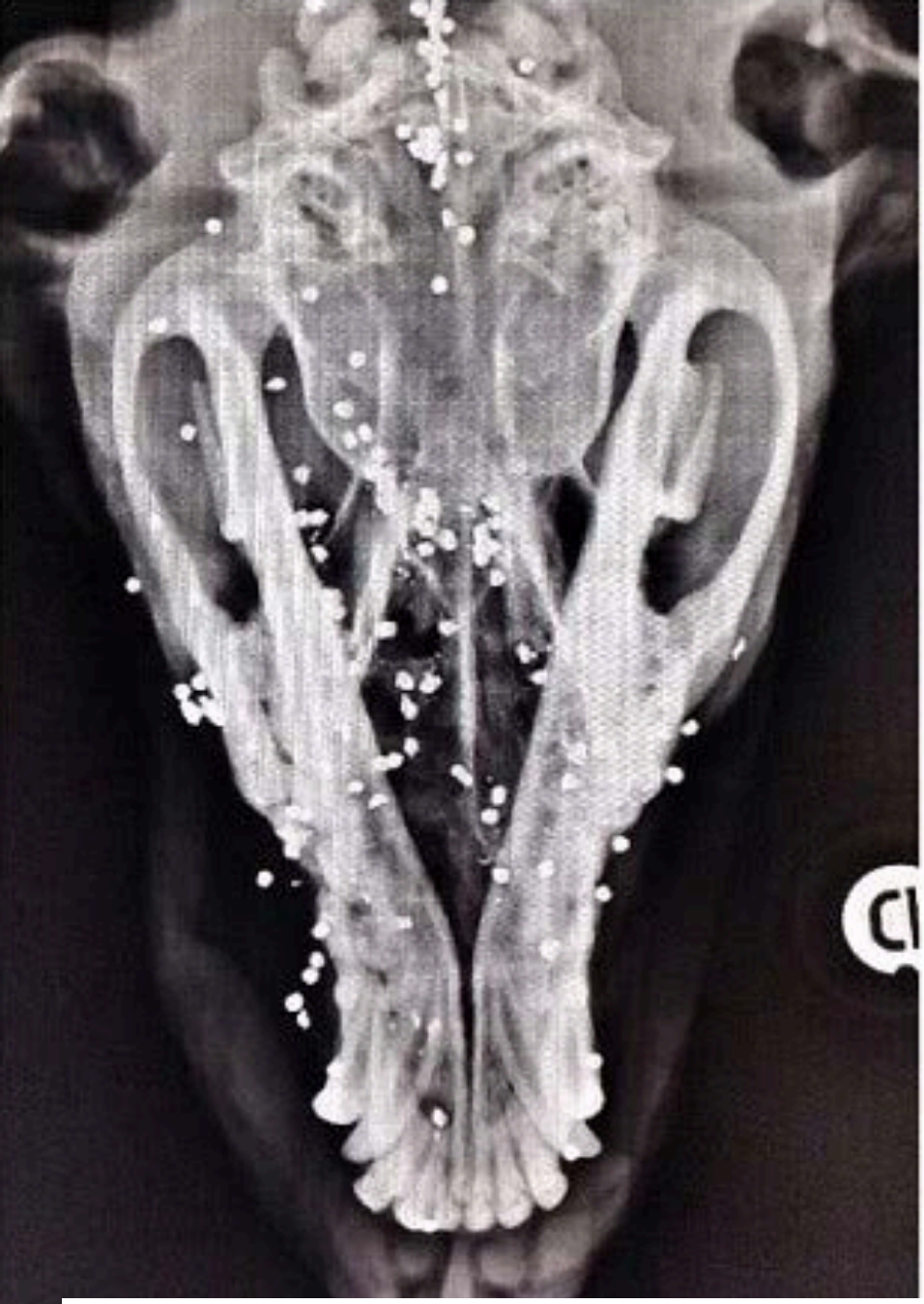
Dog with perforating thoracic gunshot wound, hemothorax, & moderate decomp. PM changes were complicating lung exam. The pluck was intubated & placed in a shallow tub of water.

Lungs after inflation. Area of lung perforation leaked air, causing bubbling in the of water.

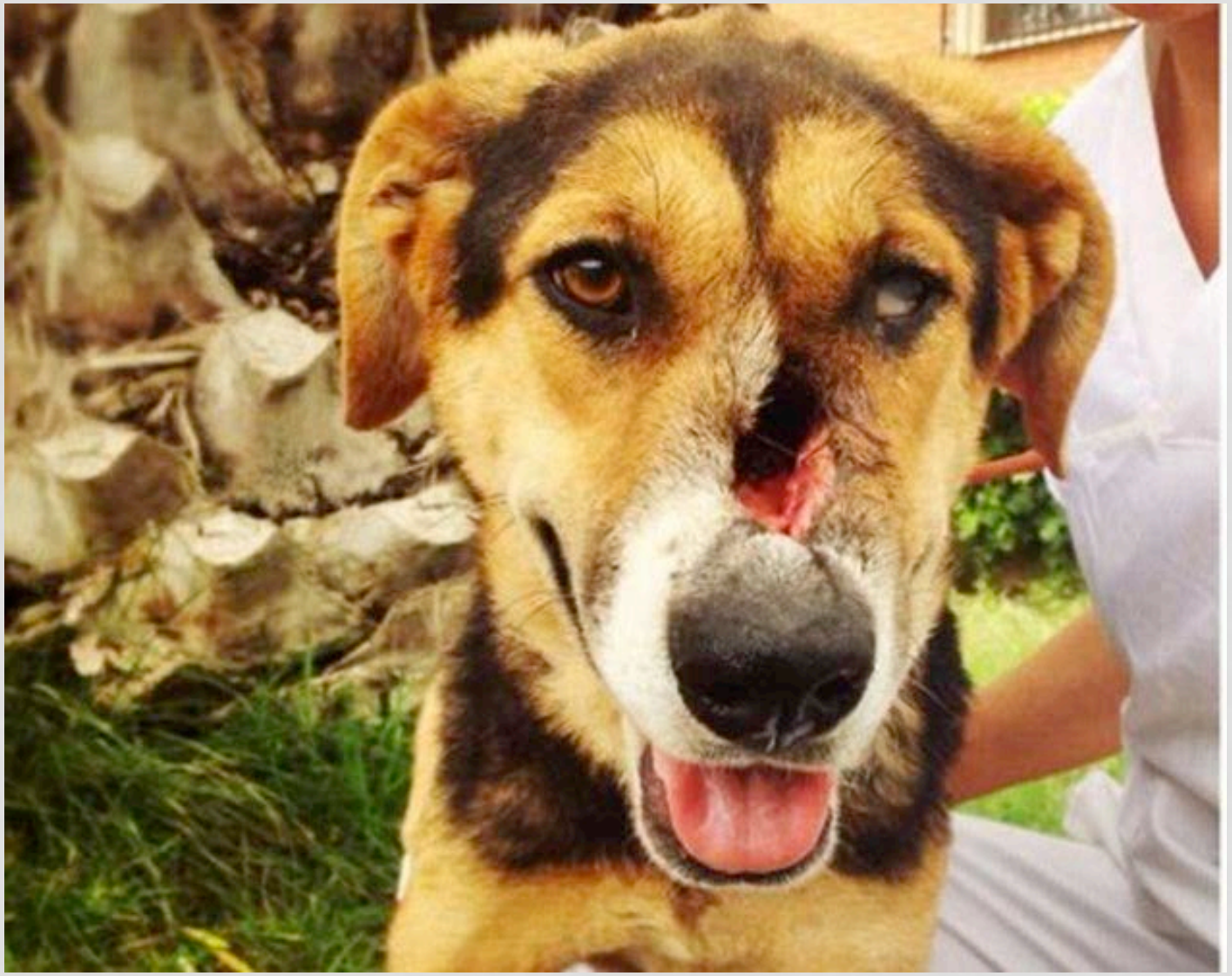
Gunshot wound. Central defect with a red-black rim leaking air (hemorrhage & necrosis– vital reaction).

Postmortem knife cuts also caused air leaks, but were not associated with a vital reaction.

Pop Quiz! Entry or Exit? Type of firearm?



Atypical firearm wounds are challenging! Xrays are best.



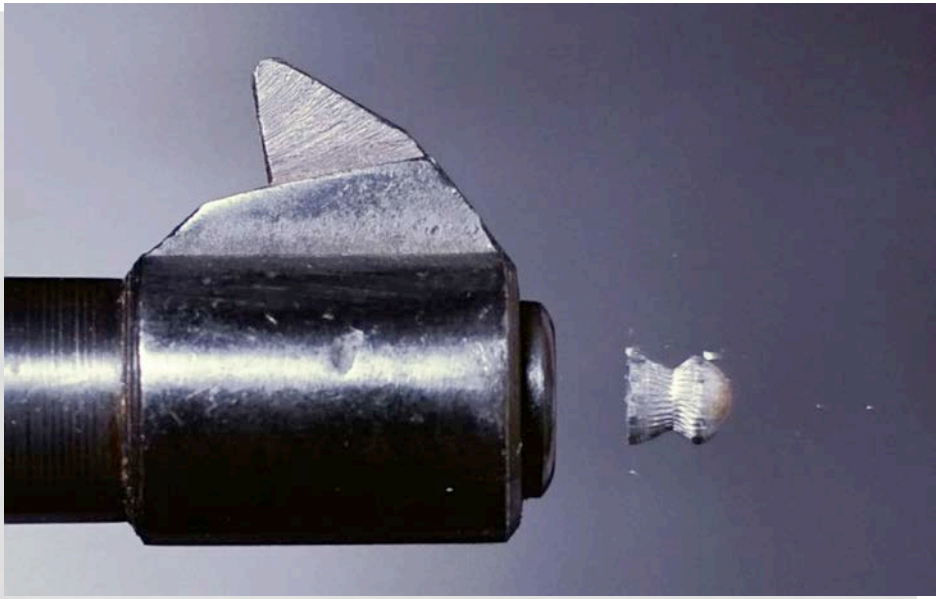
EVALUATING FIREARM WOUNDS

- 1st inspect & photo document all wounds ***without altering anything***
  - Note size, shape, abrasion ring, protruding tissue
  - Note any beveling, searing, soot or tattooing
  - If you cannot ID entry wound, re-construct wound edges to determine if central defect is present
- For Entry Wounds:
  1. Wipe with white paper towel & look for **soot**
  2. Shave around the wound, looking for **tattooing**
  3. Inspect for **vital reaction**
  4. +/- Save (formalin) skin for **histo**
     - Soot/powder/cauterized tissue confirm firearm entry wound

PROJECTILES AS EVIDENCE

- **Projectiles & fragments must to be collected**
  - A ballistics expert may be able to determine bullet caliber from the total weight of fragments
- **Photo *in situ*** & ***out of situ,*** with a scale
- Shotgun pellets or highly fragmented? Recover a representative #
- ***Use fingers* to handle**; **NEVER metal instruments** Metal-on-metal ruins ballistic pattern
- **Wash**, **dry**, & place in sealed **paper envelope**
- Start CoC form
- Store –OR– ship to someone else for analysis


POWERLINE
MODEL 15XT
ROGERS, AR. 72757
OUTDOOR PRODUCTS
Crosman



AIR (BB) GUNS

AIR GUNS

- Come in a range of sizes: handgun to rifle
- Ammunition is typically either
  - Pellets (Mushroom / Pawn)
  - BB (spheres)
- Propellant = Compressed air
  - Projectiles travel 75% slower vs. bullets (→ much less KE)
  - No flame, soot, or gunpowder →
    - All entrance wounds look alike regardless of range
- Lack rifled barrels
  - Projectiles cannot be matched to specific weapon

AIR GUNS

- Typically create a **small, circular entry wound**
  - Little to no abrasion ring
- Irregularly shaped exit wound
- **Because of low KE…**
  - Pellets often remain in the body
  - No temporary cavity
    - Tissue injury is limited to the path of the projectile
  - DO NOT fragment
    - They are too low velocity/ low KE to fragment
    - If the projectile is fragmented, it was not from an air gun.

Crow (*Corvus brachyrhynchos*). Entry wound with minimal abrasion, & neither char, nor soot, nor tattooing.

Air gun wound or a distant-range shotgun wound?

What might distinguish these 2 possibilities?

The <u>projectile shape</u> *might* differentiate:

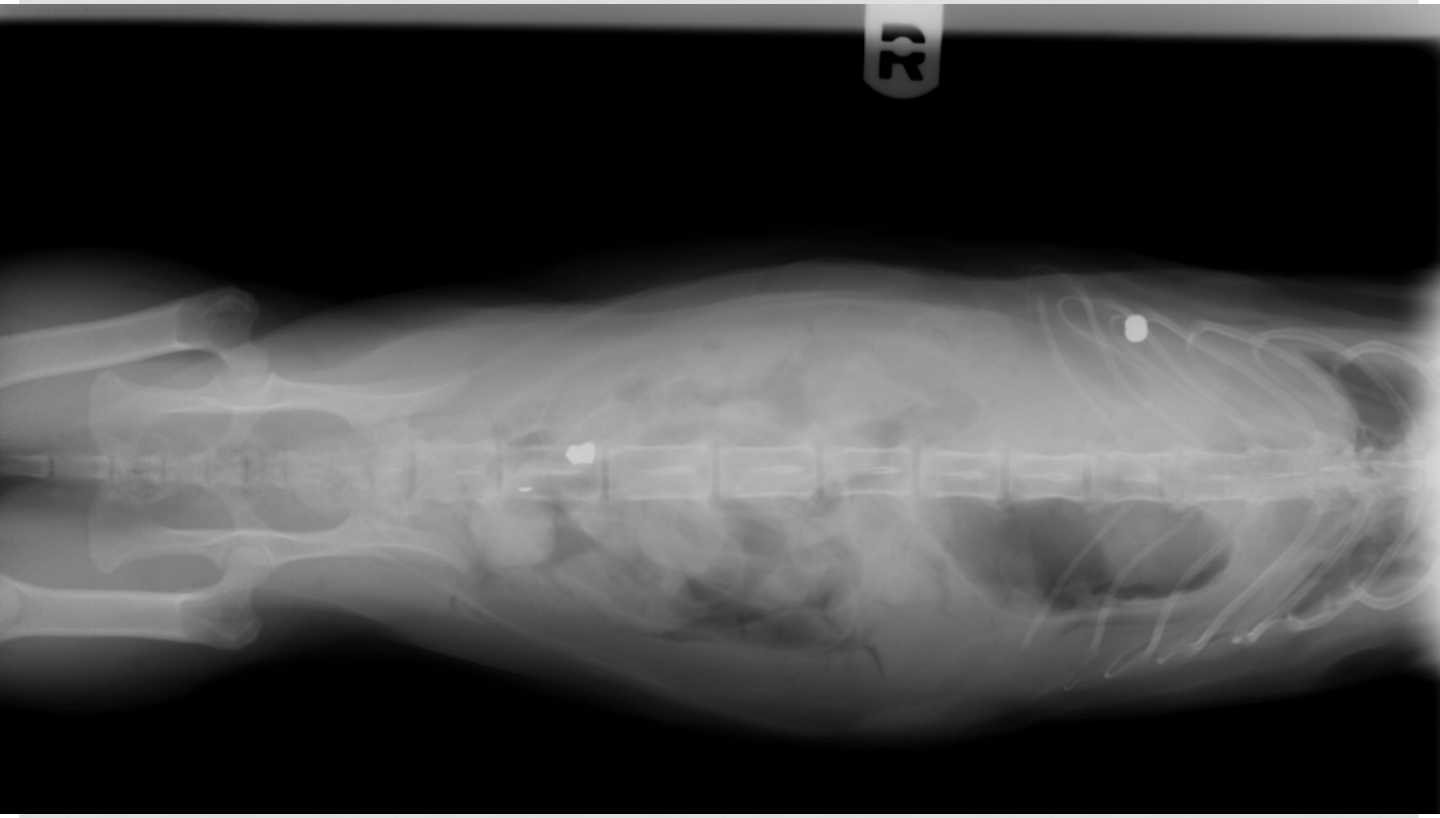
If mushroom shape→ Air gun

If sphere→ air gun or shotgun (cannot tell)

PROJECTILE NECROPSY GOALS

PROJECTILE WOUNDS: RADS

- **Radiographs *prior to Nx*** are critical
  - Projectiles present?
  - Location?
  - Excellent way of documenting the injury
  - Can help ID the projectile and/or weapon (arrow, bullet, shot, etc.)
- **Always obtain 2 orthogonal views**
- Radiographs CANNOT be used to determine the size (caliber) of the projectile
  - Magnification effect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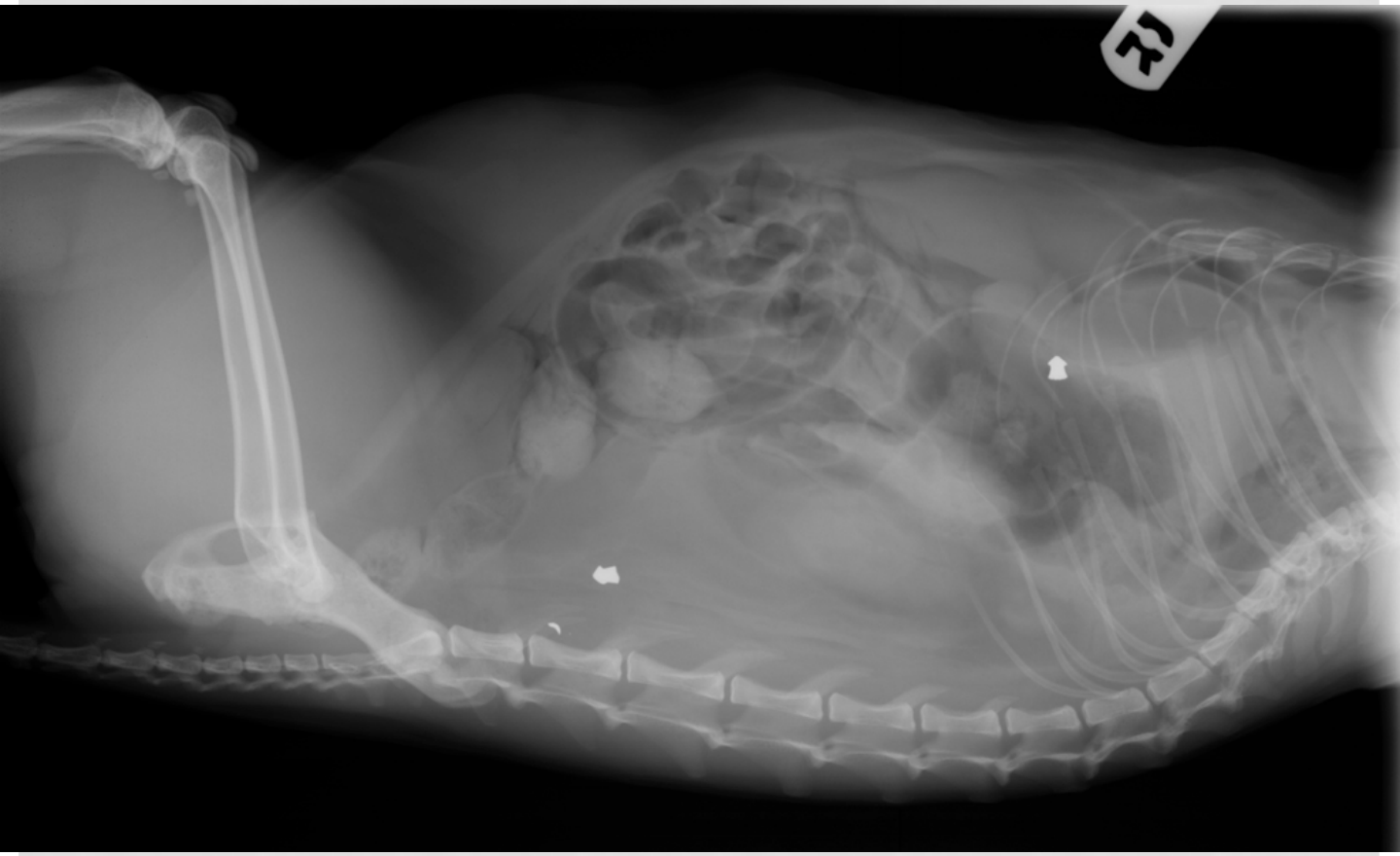
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SUMMARY: PROJECTILE NX GOALS

1. ID **entrance & exit** wounds
   - +/- **Abrasion ring** & **beveling**
     +/- **searing**, **soot & powder/ tattooing**
2. Document the **extent of the injury**
3. Recover the **projectile** (if present)
   - **Color ("grey metal"), Shape, +/- Deformation**, ~ **Diameter**
4. Determine **direction of fire** (position of shooter)
5. Determine **type of weapon & ammunition**
6. Determine **range** (*Firearms only*)
7. **Pain & suffering** (duration of survival)

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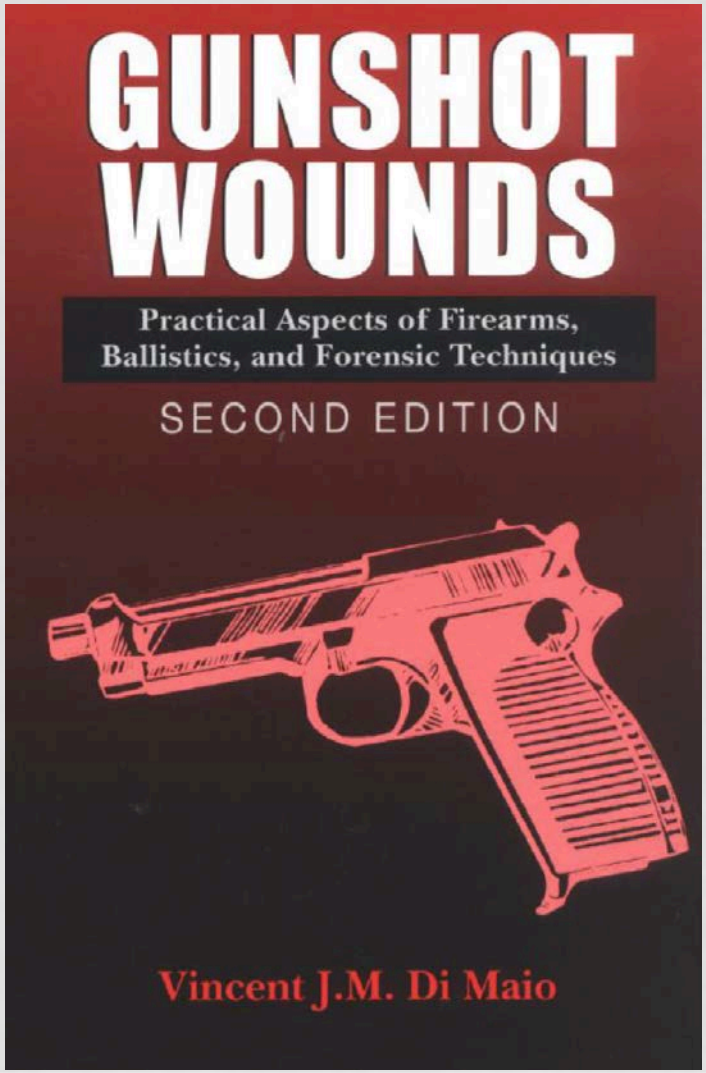
GUNSHOT WOUNDS
Practical Aspects of Firearms, Ballistics, and Forensic Techniques
SECOND EDITION
Vincent J.M. Di Maio

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EXAMPLE NX REPORT

Dog. Gun shot wound of chest:

An 0.8cm diameter circular wound (**entrance gunshot wound**) is in the left pectoral region of the chest, medial and cranial to the left cranial thoracic nipple, 15cm ventral from the left ear & 5cm left of the ventral midline. The abrasion collar is widest along the lateral aspect between 1 and 4 o'clock. No soot deposition or gunpowder stippling is on the skin or in the surrounding soft tissues.

The wound path sequentially runs through: the left 3rd intercostal space, the cranial portion of the cranial lobe of the left lung, the pericardial sac, the heart, the lower lobe of the right lung, & the right 8th intercostal space caudally, ending in the subcutaneous tissue on the right side of the lateral thorax. The path through the heart is described in further detail:

EXAMPLE NX REPORT

Dog. Gun shot wound of chest (con't):

The path through the heart begins as a circular perforation on the cranial aspect of the right ventricular outflow tract, then continues through the base of the heart at the root of the aorta and pulmonary artery. It leaves the heart at the origin of the pulmonary vein.

At the end of the wound path, a moderately deformed, non- jacketed, small-caliber lead bullet is recovered from the right side of the back 27cm dorsal to the xyphoid, and 4cm right of the dorsal midline.

EXAMPLE NX REPORT

Dog. Gun shot wound of chest (con't):

Associated findings: hemorrhage into tissue along the wound pathway, estimated between 12 and 20 mLs; 180 mls of blood in the pleural cavity; 40 mls of blood in the pericardial sac. The right and left lungs are estimated to be ~50% collapsed.

The direction of the wound path is left to right, front to back, and downward.