

# Blades and Bullets: Questions for the Medical Examiner

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This is what a comprehensive overview of Gunshot Wounds and Sharp Force Injuries looks like



And this is the time we have.



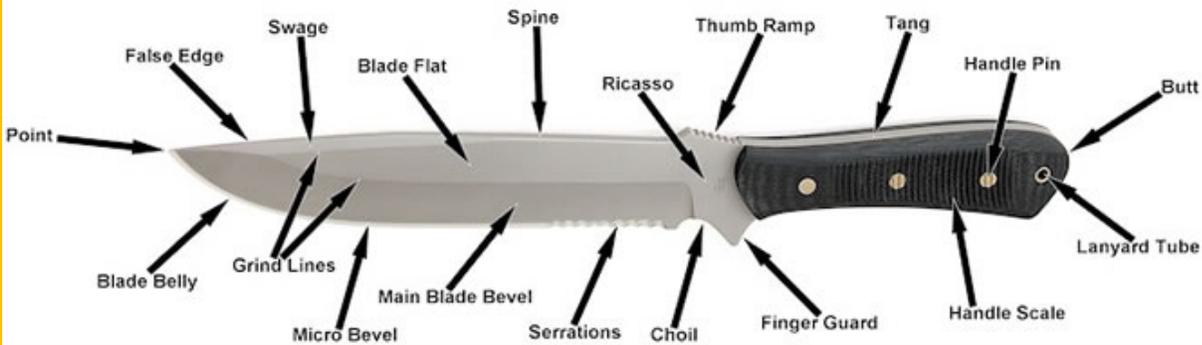
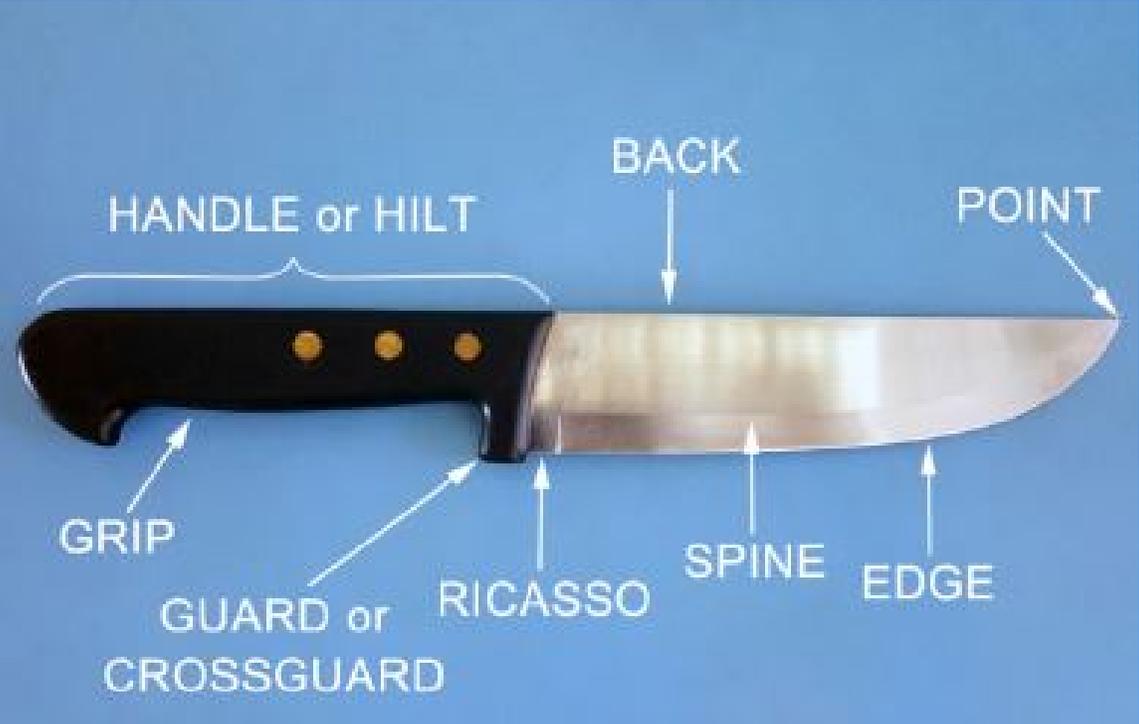
# So...

- This presentation will focus on the kinds of questions I've been asked throughout the last 20 years by attorneys involved in cases involving gunshot wounds and stab wounds.
- It's basic, but I'm happy to answer questions afterwards if you would like more detail.
- Remember that, often, questions on these subjects are very case-specific. There are no algorithms.
- When you need assistance with GSW and Sharp Force Injury cases, have a go-to forensic pathologist you can consult.

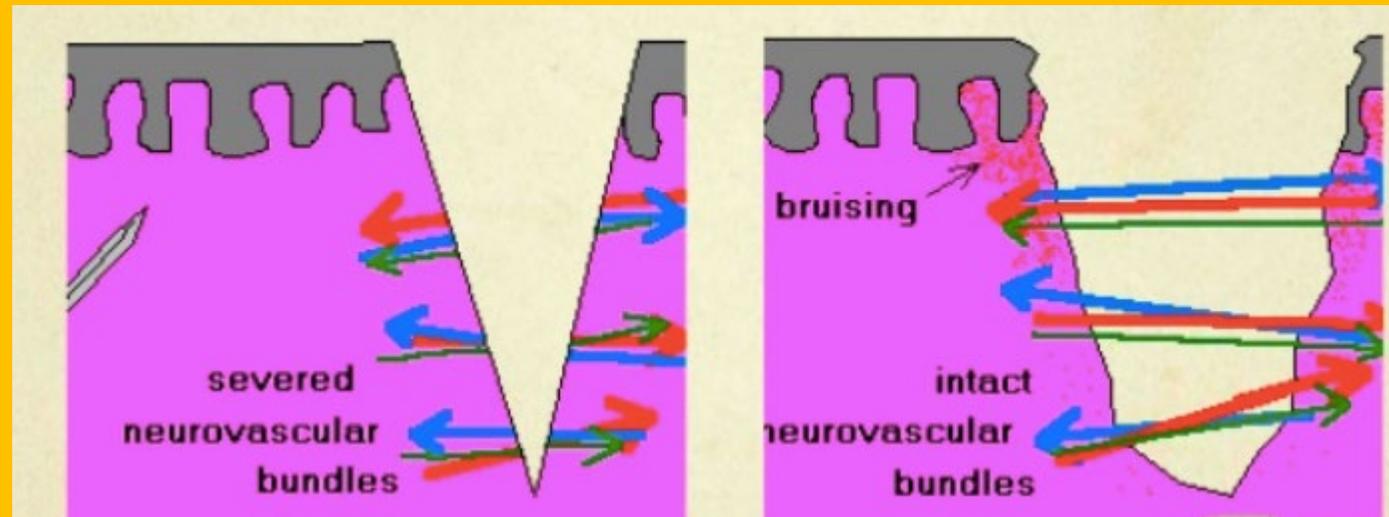
# Sharp Force Injuries



First, its good to understand the terminology



What's the difference between an incision and a laceration?



# Laceration vs. Incision



Laceration: **blunt force injury**  
jagged edges  
abrasion/contusion to the edges  
tissue bridging between the sides  
of the wound

Incision: **sharp force injury**  
clean, straight edges  
No abraded edges  
No tissue bridging

# So, what's a "cut"?

- in lay terms, this is often used to describe incised wounds as well as lacerations (a blunt force injury)
- It's often hard to know what is meant by this

# What's the difference between an incised wound and a stab wound?

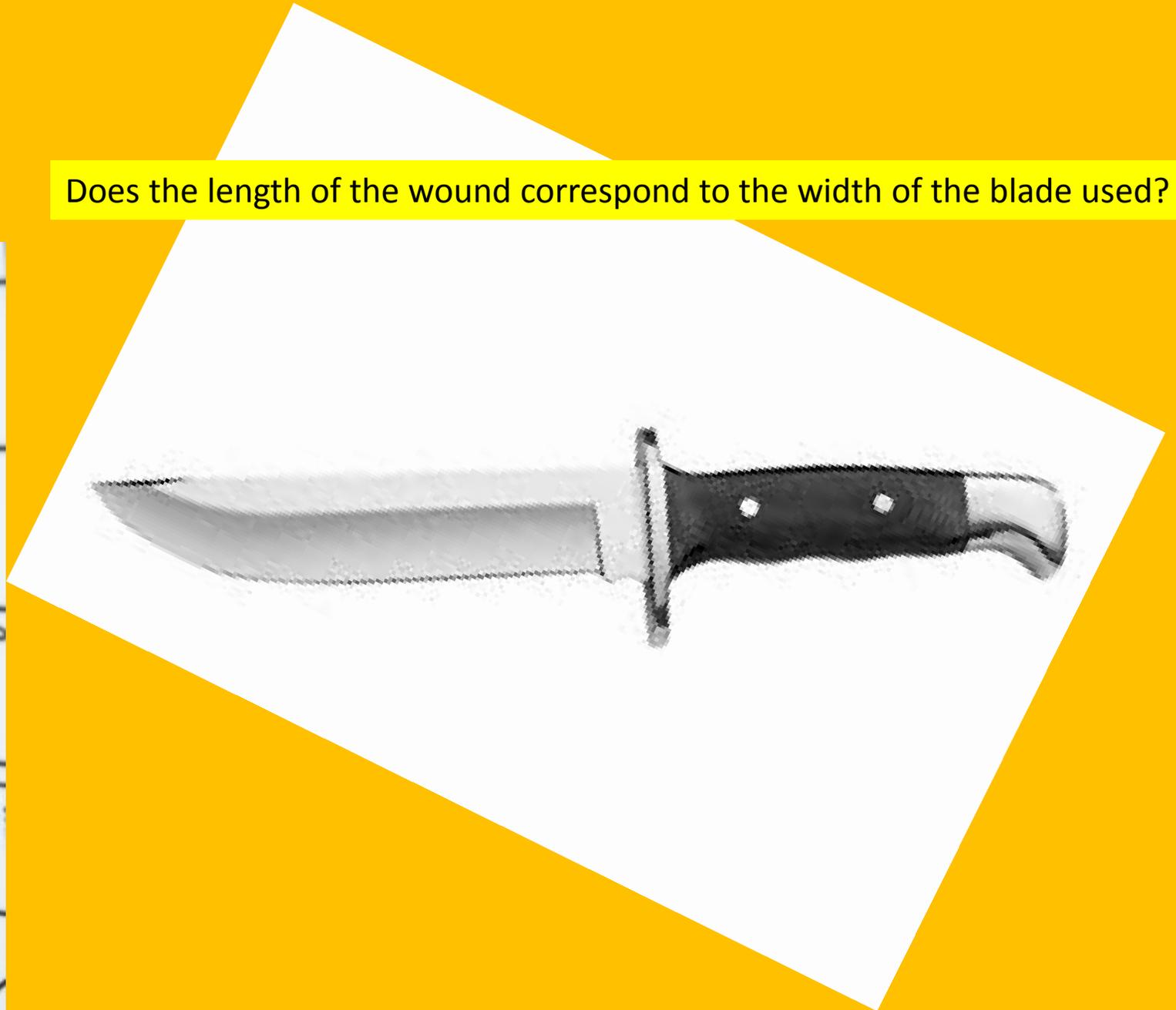
- “Incised wound”: injury created with a sharp edged instrument which is longer than it is deep
- “Stab wound”: injury created with a sharp edged instrument which is deeper than it is long
- BUT, you can have a deep stab wound that involves a longer incision as it is removed: “stab/incised” wound, stab wound with a long incised wound extending from one edge, etc.

# What characteristics does a FP look for in Sharp Force Injuries?

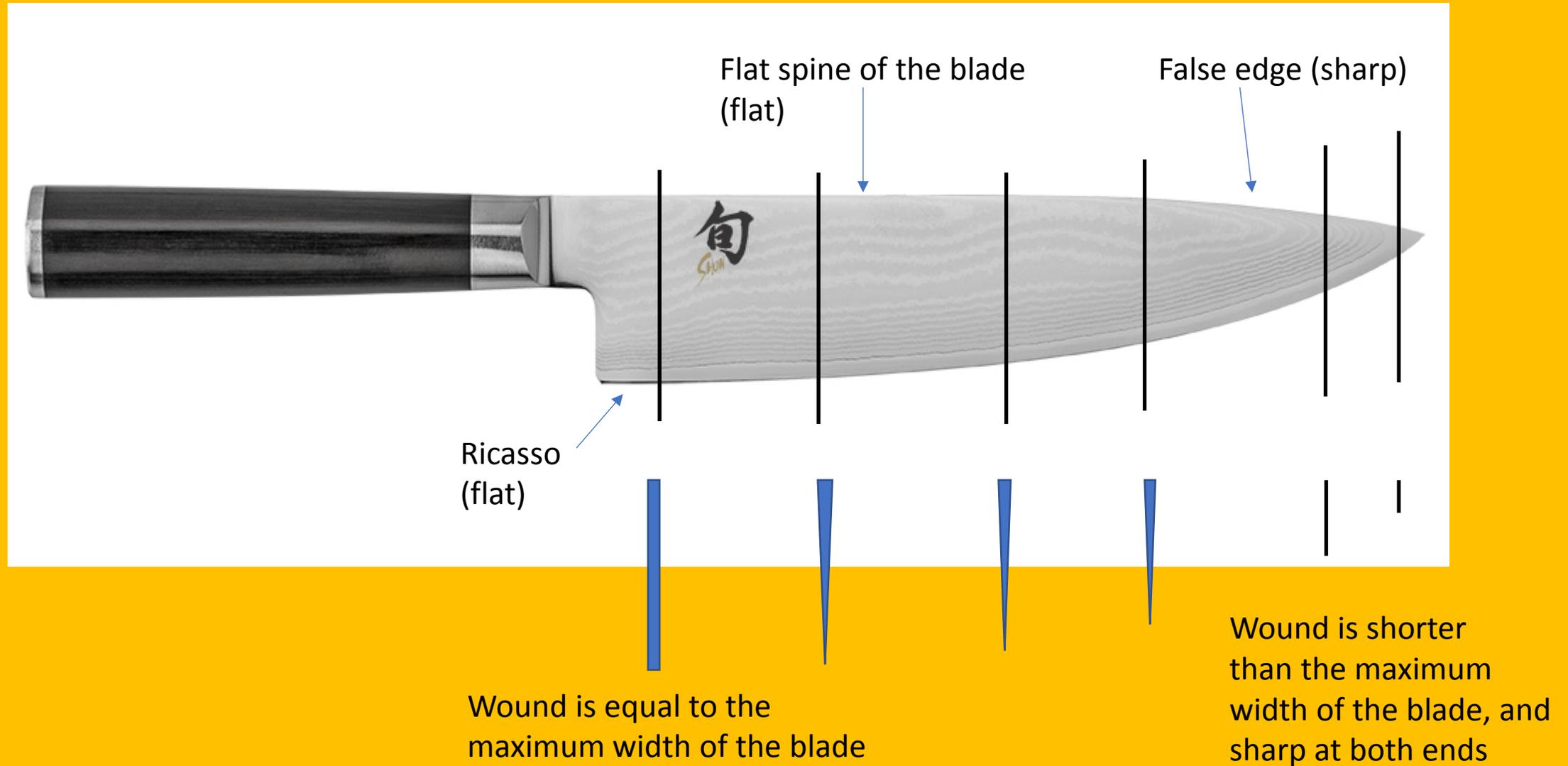
- We approximate the edges of a wound, in order to measure the **length**
- We look at **the “ends”** of the wound: sharp end/squared off end or two sharp ends
- Look for **abrasions and/or contusions** to the surrounding skin
  - Handle injuries/Hilt marks
  - Serrations from the blade
- Look for more superficial **“tails”** trailing off from the wound
- Look for forked injuries or **branching** injuries along the wound
- Look for **defense** type injuries
- Look for **hesitation** injuries

# Stab Wounds

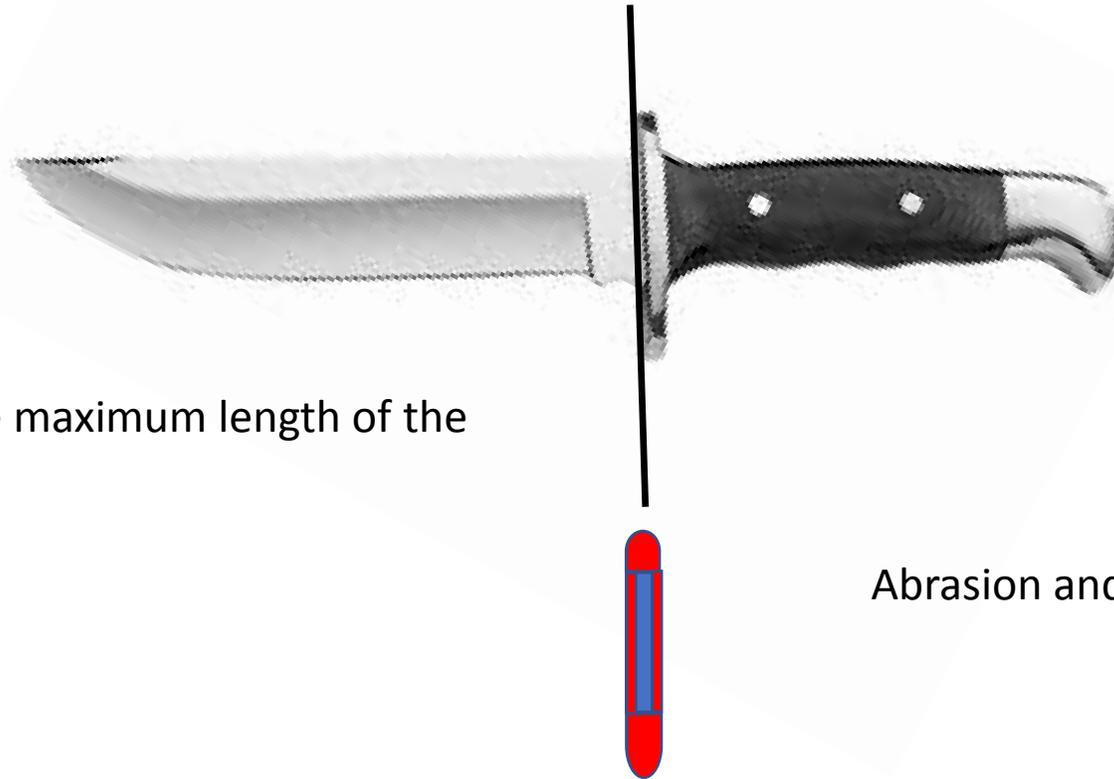
Does the length of the wound correspond to the width of the blade used?



The wound can be equal to or less than the width of the blade



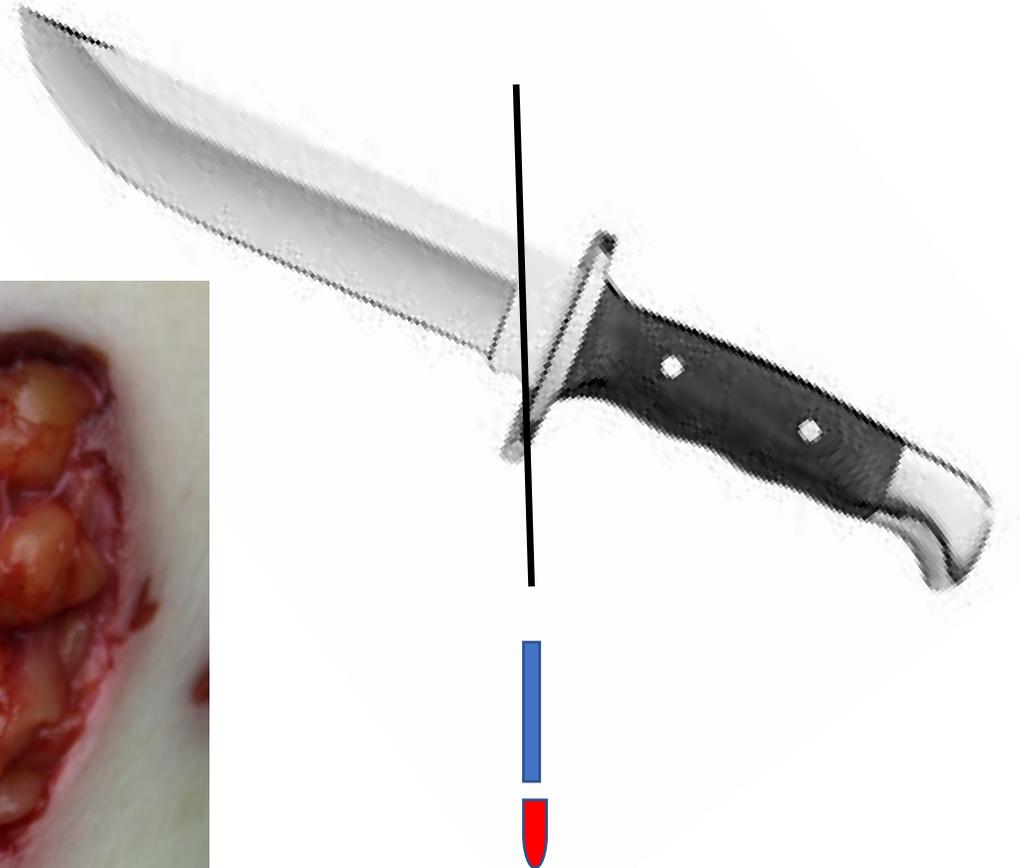
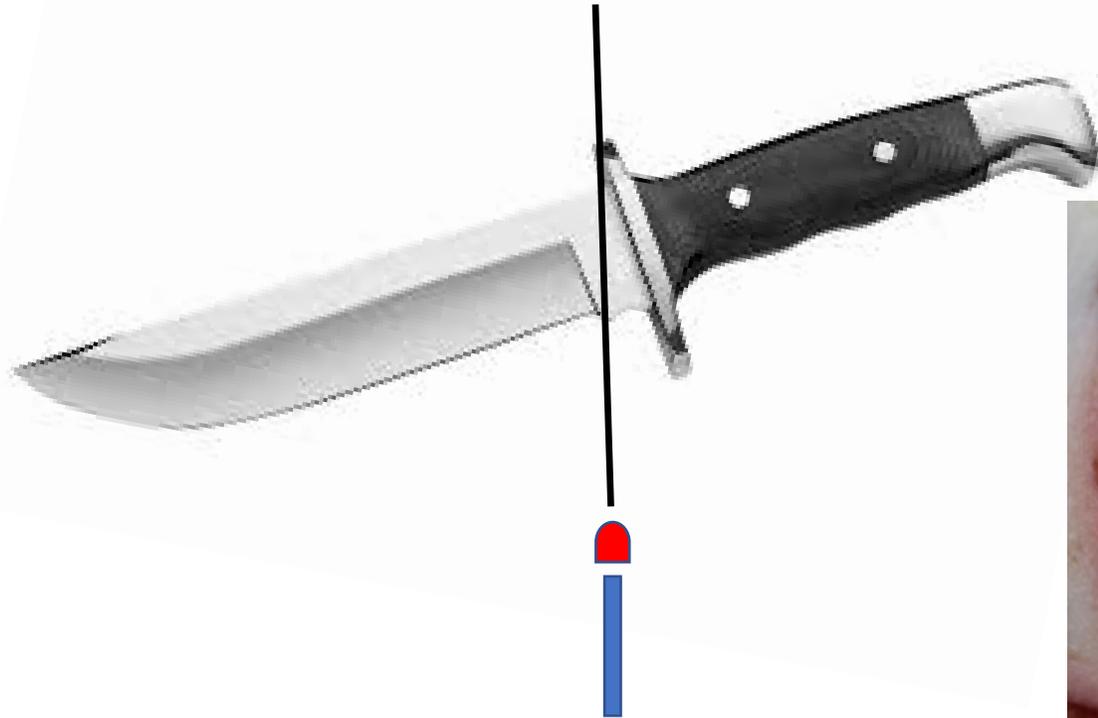
# Handle/Hilt marks



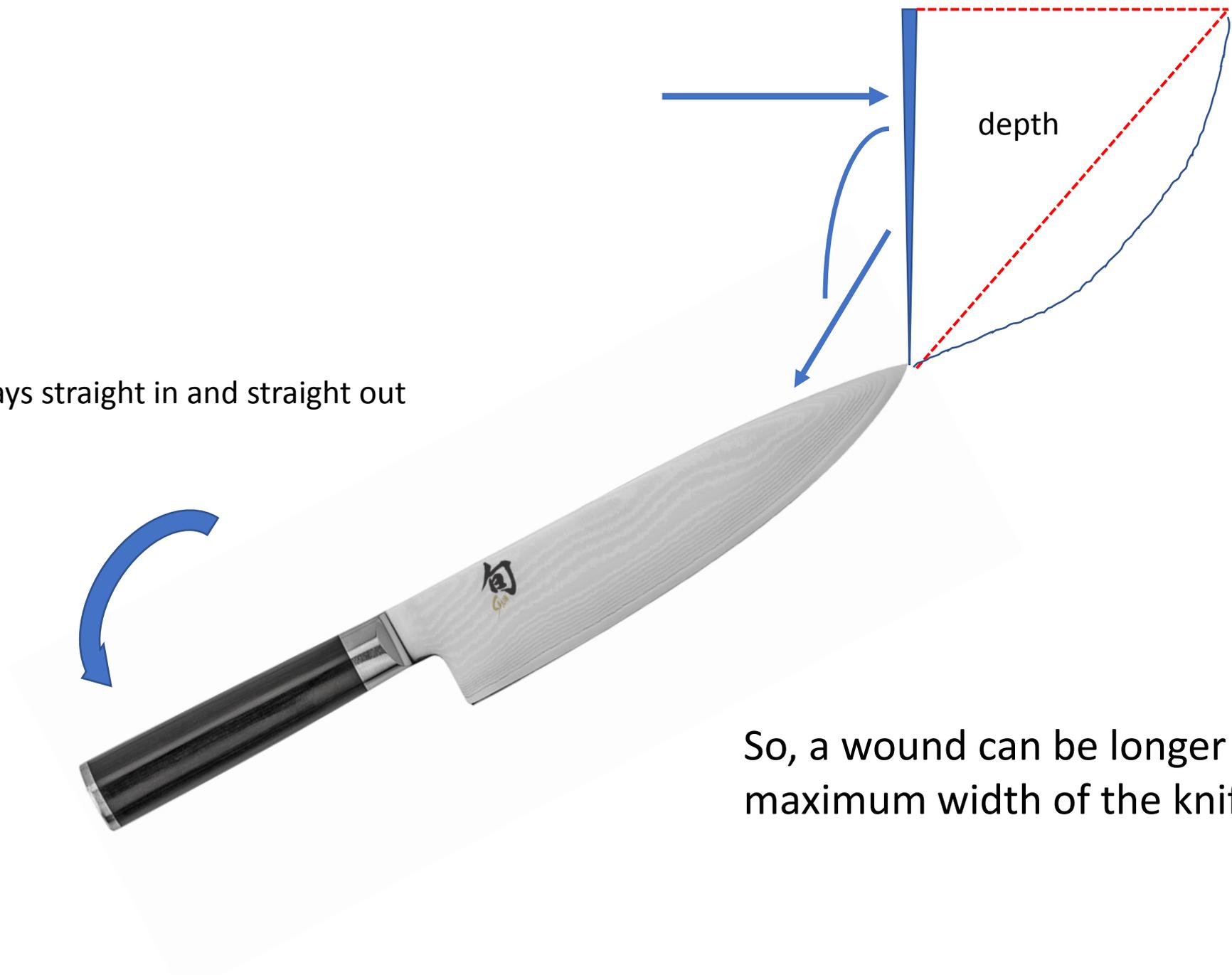
Knife is inserted to the maximum length of the Blade in these cases

Abrasion and/or contusion around stab

Not always a perpendicular entry

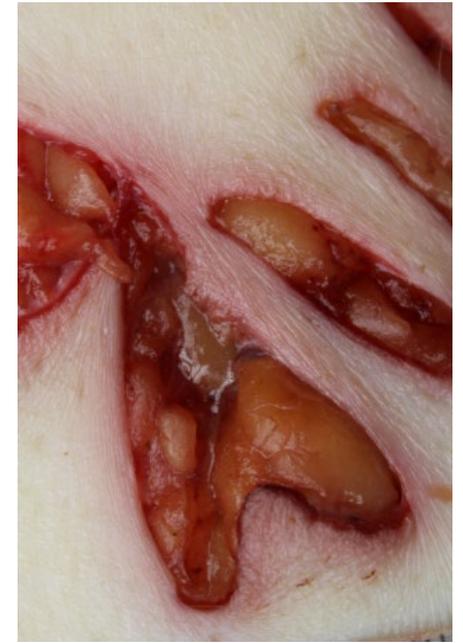


It's not always straight in and straight out

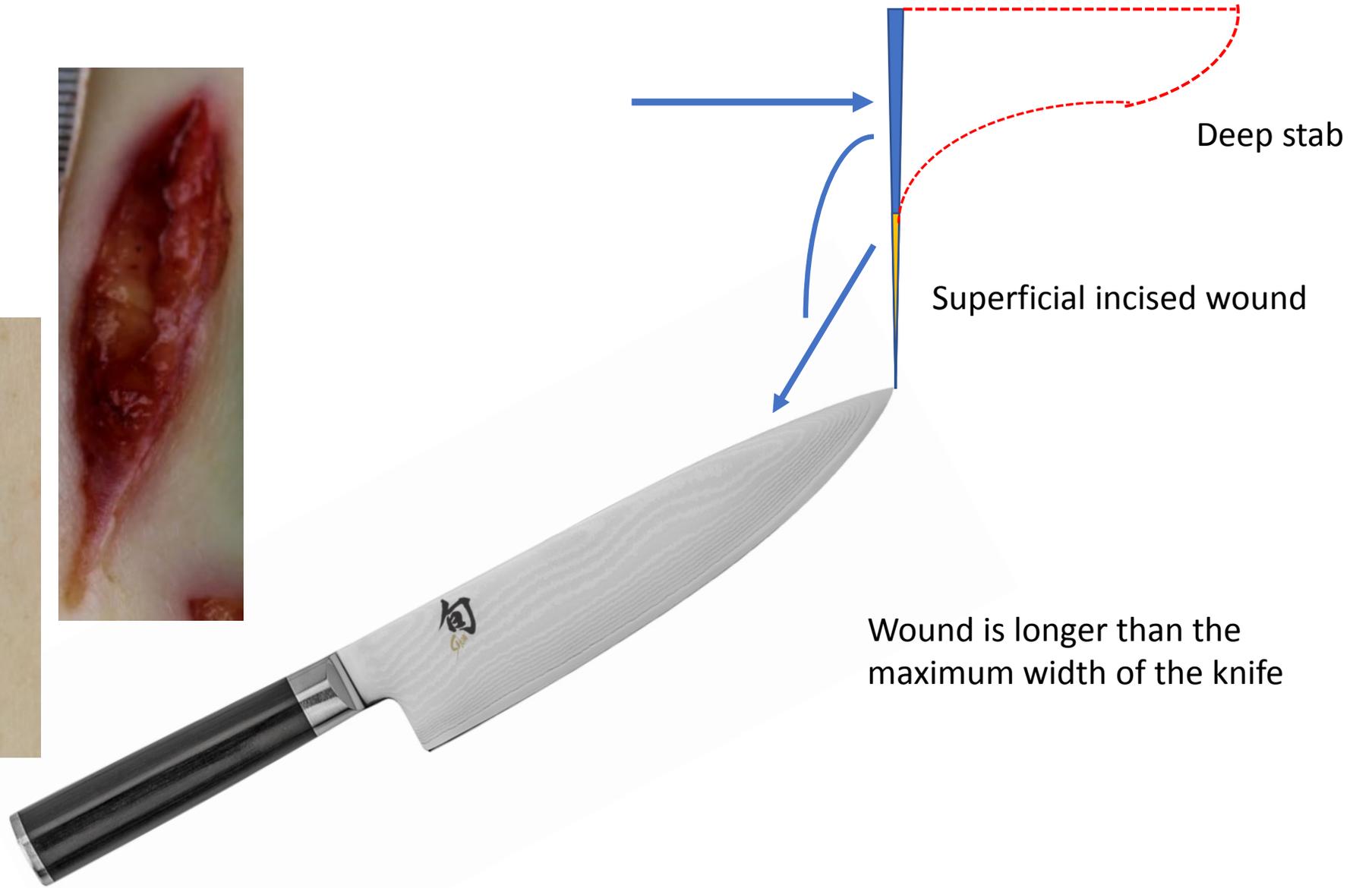


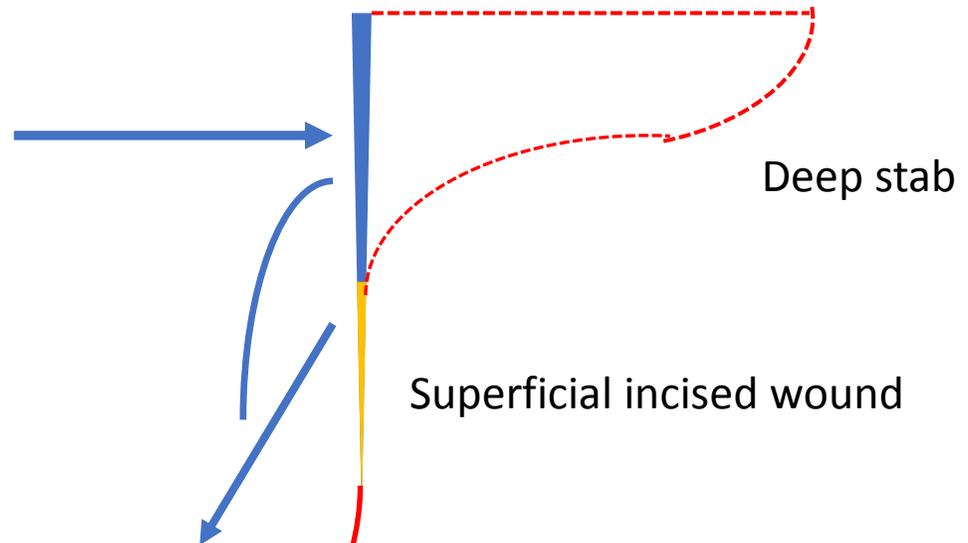
So, a wound can be longer than the maximum width of the knife

# When the knife turns



It could just be a small  
"fork" to one end





Deep stab

Superficial incised wound

Even more superficial  
incised wound or  
Scratch abrasion to skin

Wound is much longer than the  
maximum width of the knife

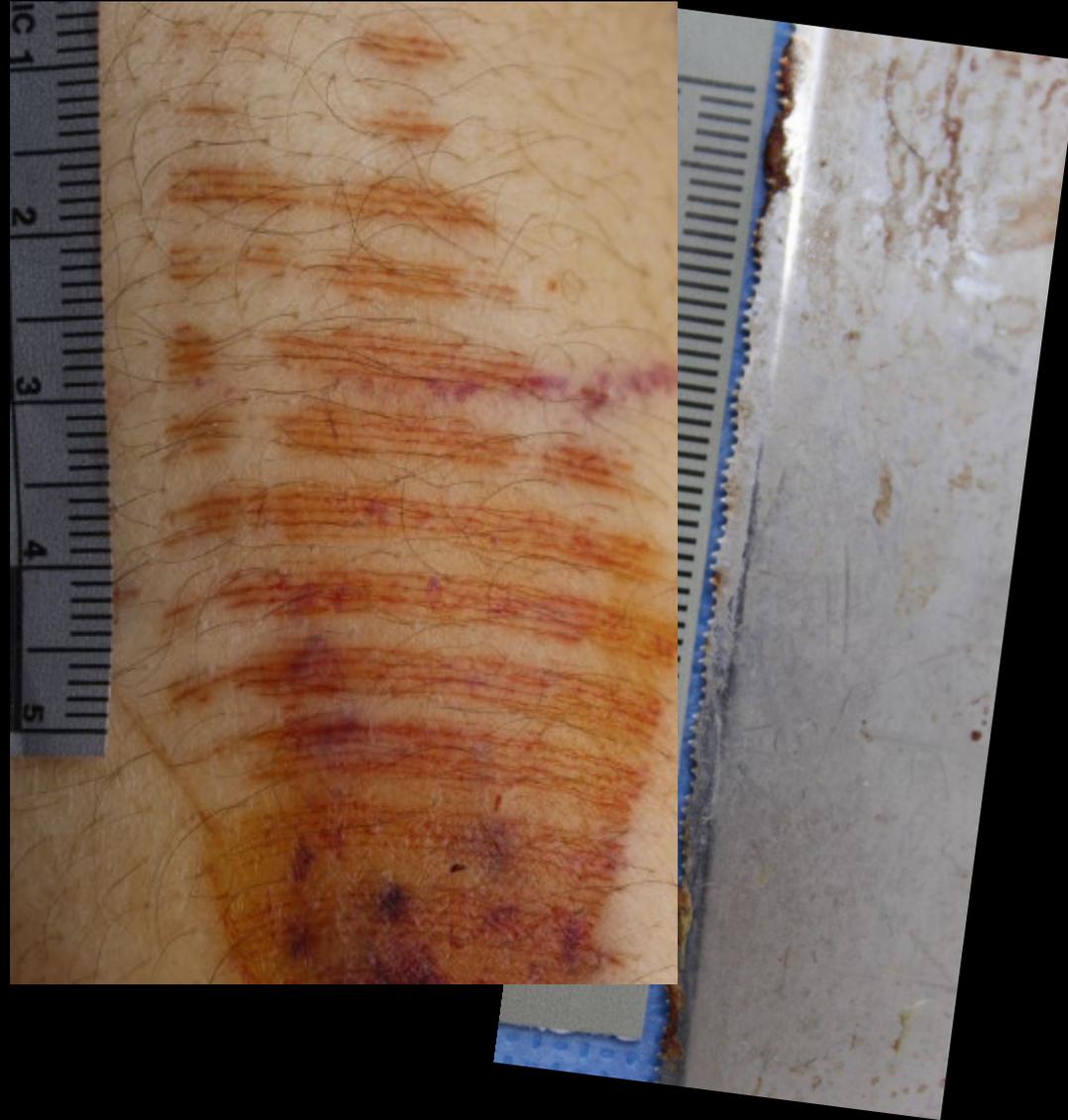
So, when you see this type of thing it means that the victim was moving, trying to get away or fighting for their life?

- It means that the weapon moved in relation to the body
- It could mean that both the attacker and victim were moving, or that one of them was moving in relation to the other
- Yes, it could mean the attacker “twisted the knife”, but it could also mean that the victim turned their body

Look for abrasions that suggest a serrated edge to the blade

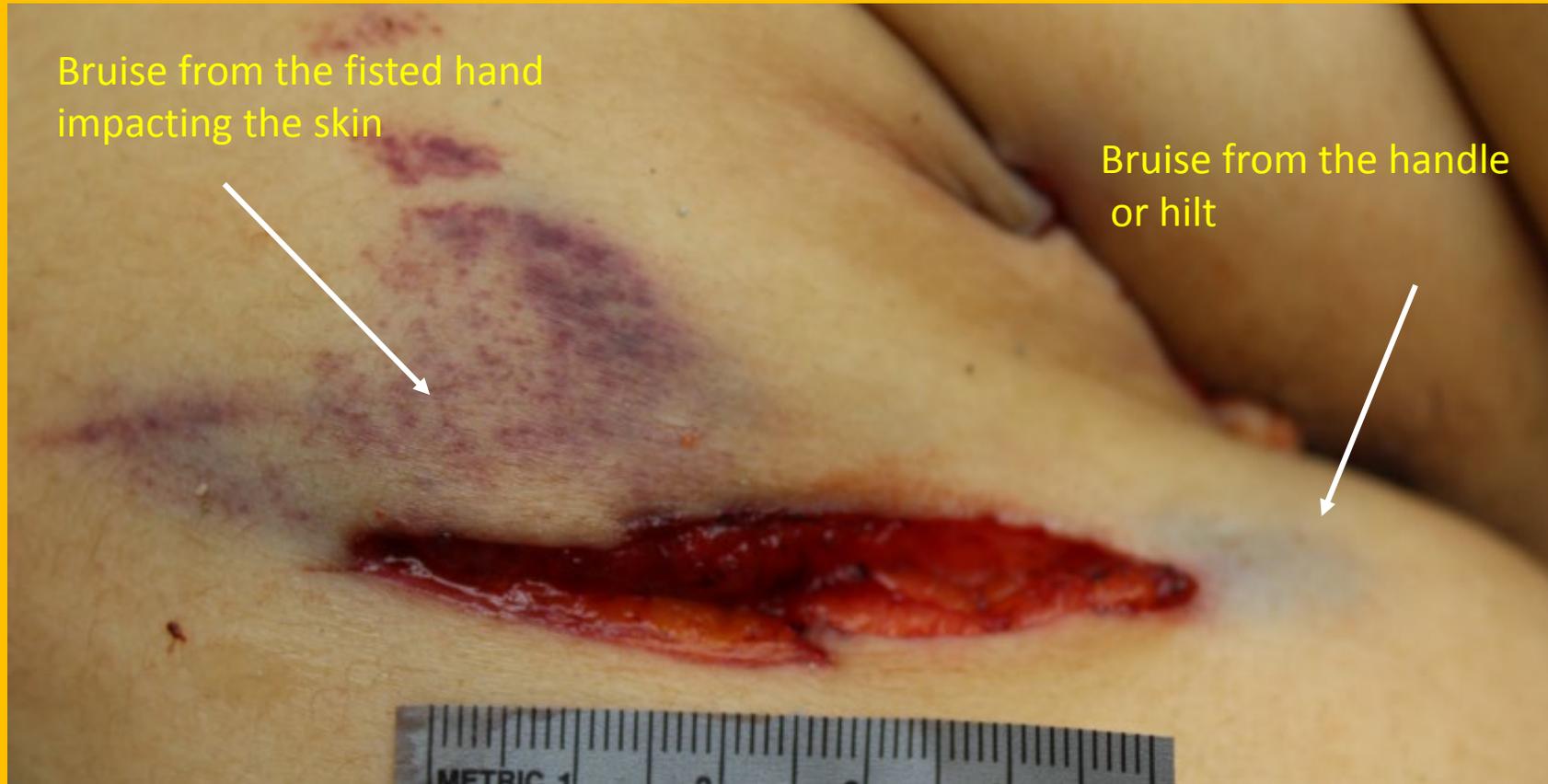


# Comparison to a broken knife blade at the scene

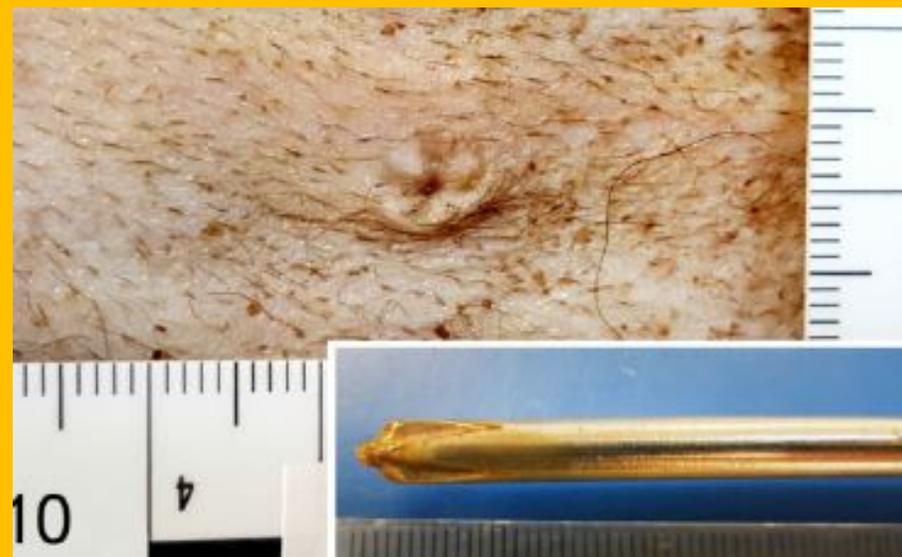
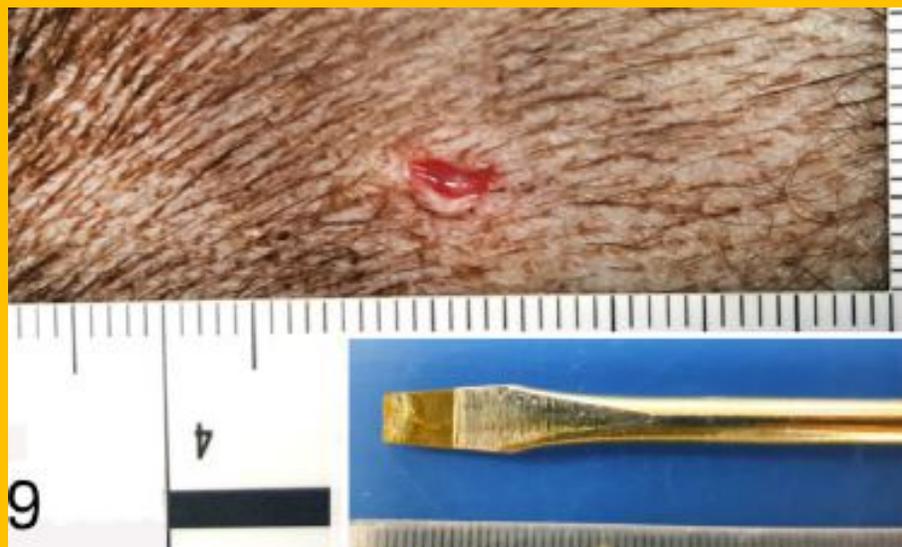


This is why we like for suspected weapons to be brought to the autopsy

# Contusions to the surrounding skin



Not all stab wounds are caused by knives



But, again...



# Just remember that there are lots of patterns of Sharp Force Injuries

- Scissors
- Forks
- Icepicks
- Broken glass
- Axes
- Propellers

# Can you determine the depth of the wound and therefore the length of the blade/weapon?

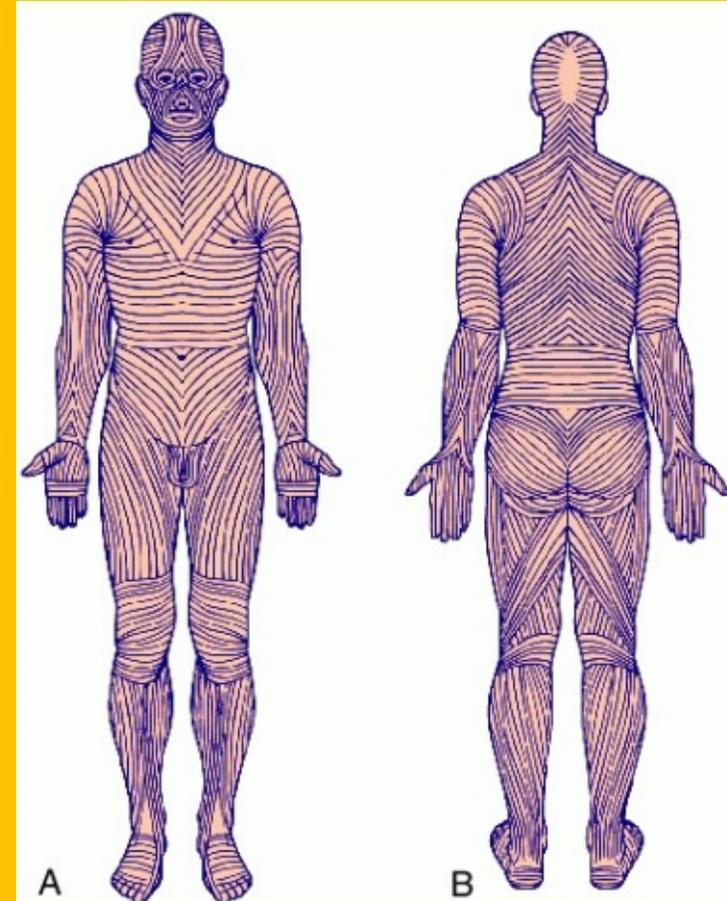
- The depth may be **less** than the blade length if not fully inserted
- The depth may be **greater** than the blade length due to the compliance of the body (compression of the abdominal wall or chest wall)
- In some circumstances, the depth can be approximated with some accuracy, but the possibility of a partial insertion or compression of the surface must be acknowledged
- As a FP, I think it's best to consider whether the suspected weapons are "consistent" or "inconsistent" with the wounds

# Can the direction of the wound path be determined?

- With careful dissection, the wound path can be traced in many cases
- Can be impossible in some cases though (muscle tissue)
- When considering the path involving organs, one must remember that the organs may “hang” lower when in a standing position...
- And that the organs may move during life (diaphragms contracting/relaxing, lungs expanding/collapsing, heart contracting and relaxing)

# Why are some wounds large and gaping while others are thin?

- Cleavage lines of Langer: lines of tension in the skin determined by the direction of elastic tissue and collagen fibers in the dermis
- A gaping wound indicates that the wound is more perpendicular to the lines of Langer, with the elastic fibers “tugging” at the edges





This is the plane of the lines of Langer in this area of the abdomen



The edges oriented more perpendicular to the elastic fibers get "tugged" on more

# What constitutes a defense wound?

- Cut and stab wounds to the upper extremities, notably the forearms and hands, caused by the victim raising their arms or grabbing the knife to ward off the attack
- May be on the lower extremities, notably if the victim is on the ground
- Not to be confused with self-inflicted “cutting” injuries (self-mutilation)—typically multiple, superficial, vertical and located to the ventral wrists and forearms (look for scars from prior cuts)

# Defensive Wounds



# Defensive wounds



# How do you discern between Homicide vs. Suicide in these cases?: Lots to consider

- Case by case basis
- Be skeptical and objective

# Suicides

- Less commonly seen than homicidal stabs/incised wounds
- Usually multiple superficial injuries (“hesitation” injuries) with only one (or few) lethal injuries
- Found in accessible areas of the body (is it possible to reach?)
  - 51% are to the left side of the chest
- No defensive wounds
- No evidence of bindings to body (incapacitation)
- Typically remove clothing from the area (expose area to be injured), 75% of time in some case studies

# Suicides

- Wounds are usually horizontal and pass between the ribs
- **No** evidence of a **struggle** at the scene
- No evidence of a struggle to the decedent or to the suspected attacker(s)
  - No other injuries to the decedent, except perhaps due to a terminal collapse
  - No injuries to the suspect
- **Knife is present** at the scene
  - But, beware of family, friends, etc. that may alter the scene
- Scene is often a secluded location, typically within a decedent's home

# Suicide

- Consider all the historical facts, along with the physical findings (and, are they facts?)
- **Risk factors**, indicators that support **suicide** (notes/texts, prior attempts and threats, significant life stressors).
- Does it make sense?

# Homicide

- A homicidal stab wound is rarely inflicted without some associated cutting
  - If no restraints on the victim, there is **movement/struggle** which imparts forked cuts to the edge of the stab and/or incised “tails”, as well as defense wounds

# Homicide vs. Suicide?: Lots to consider

## **Suicide**

- Seen less commonly than homicide
- Hesitation injuries
- Accessible areas of body
- No defense wounds
- Typically move clothing to expose area
- No struggle at scene
- No other injuries of altercation
- Horizontal stab between ribs
- Knife present at scene
- Risk factors of suicide and life stressors

## **Homicide**

- Seen more commonly than suicide
- Hesitation injuries are possible
- Poorly-accessible areas (back)
- Defense wounds
- Stab wounds through clothing
- Evidence of struggle at scene
- Usually lots of cuttings injuries to decedent and/ or suspect associated with altercation (unless bound or incapacitated)
- Vertical stabs, through ribs/sternum
- Knife absent at scene

# What about the self-defense claim by the survivor?

- Fingernail marks, scratches, and bruises on the victims body may lend support to the claim
- Such marks on the attacker may suggest the opposite
- Sometimes these injuries on the victim could be caused by the attacker, as they try to control their victim
- Take fingernail clippings/swabbings for DNA when wounds would require someone to get in close to inflict them
- We could spend a lot of time discussing this topic obviously—consider each case individually

Sometimes it's really hard to support a self defense claim



# Is there a lot of pain associated with stab wounds and incised wounds?

- The pain receptors are in the dermis of the skin, so after the injury to the skin, further insertion does not necessarily contribute additional pain
- The larger the wound, or the more in number, the more pain receptors that are disturbed
- Bone fractures/stabs will be painful (periosteum)

# How much force is necessary to stab someone?

- Less than 2 pounds of pressure is required to penetrate the skin, if the tip is sharp
- After penetrating the skin, the cutting edge of the blade requires minimal force
- Bone and cartilage require more force to penetrate however
- What does “with great force” mean, anyway?

# What is the cause of death in SFIs?

- Usually **hemorrhage**
  - Blood at the scene may be minimal if the hemorrhage is confined to the body cavities
- Wounds to the neck may result in hemorrhage, and/or **air embolism** to the lungs
- **Pneumothorax**
- **Asphyxia** from massive blood inhalation
- **Infection** (late complication)

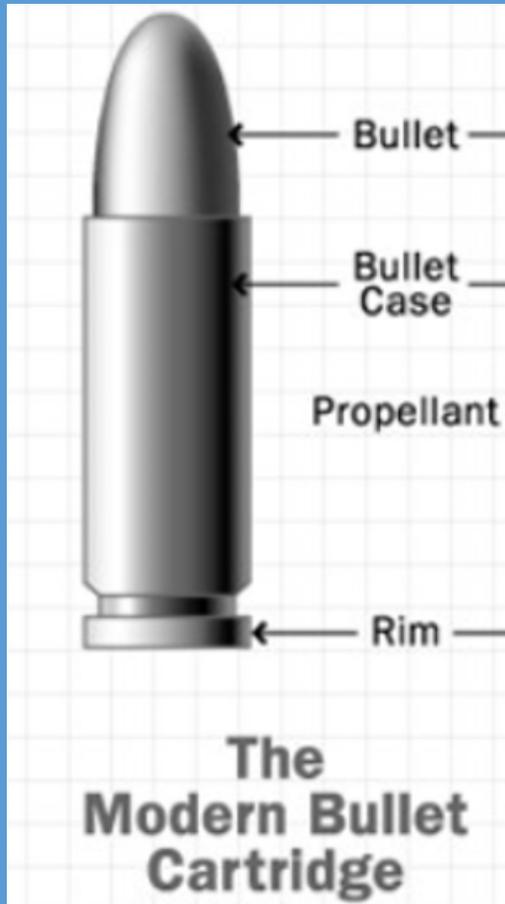
Moving right along...



# Gunshot Wounds

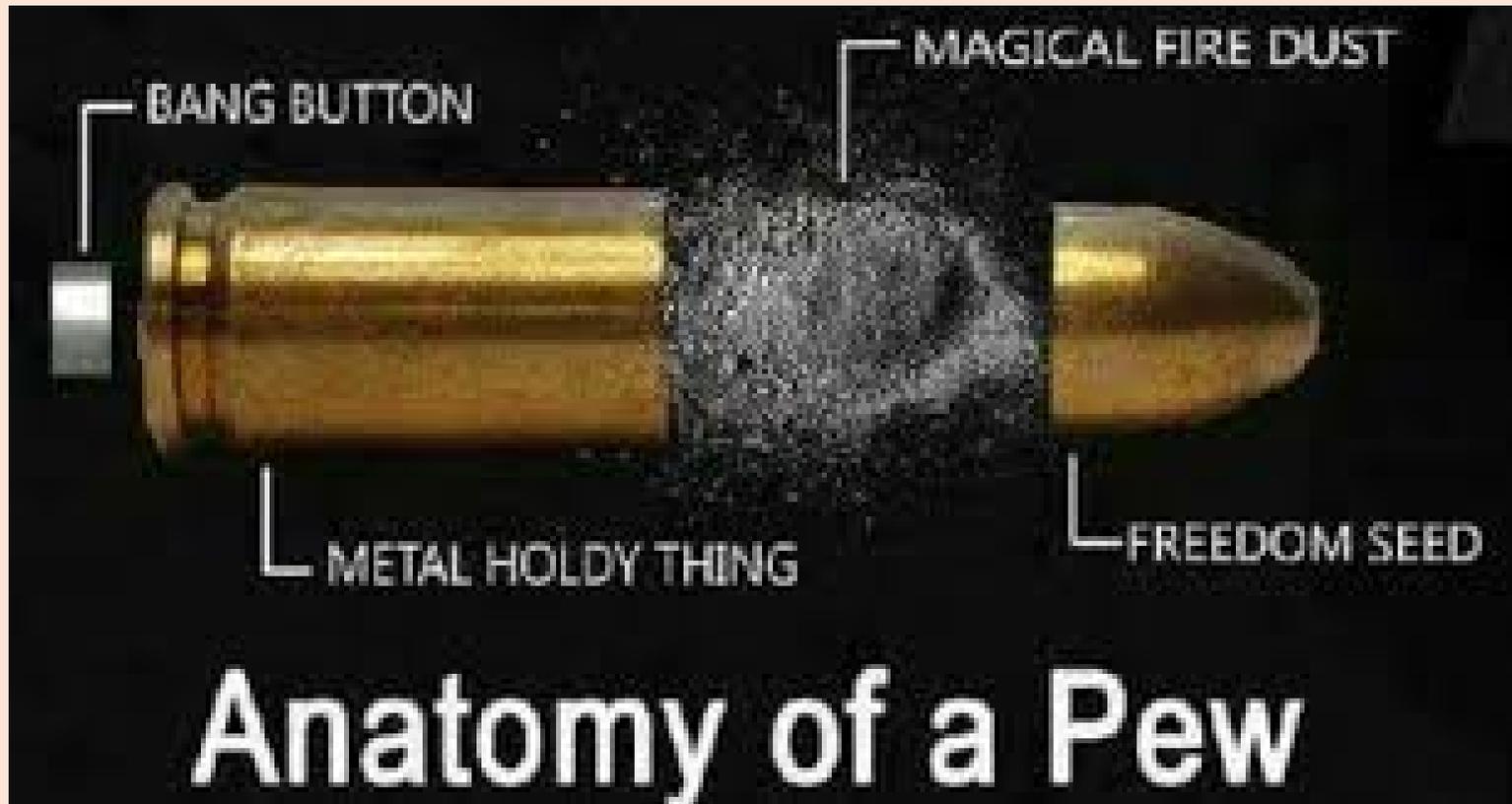


# What's the difference between a bullet and a "cartridge"?



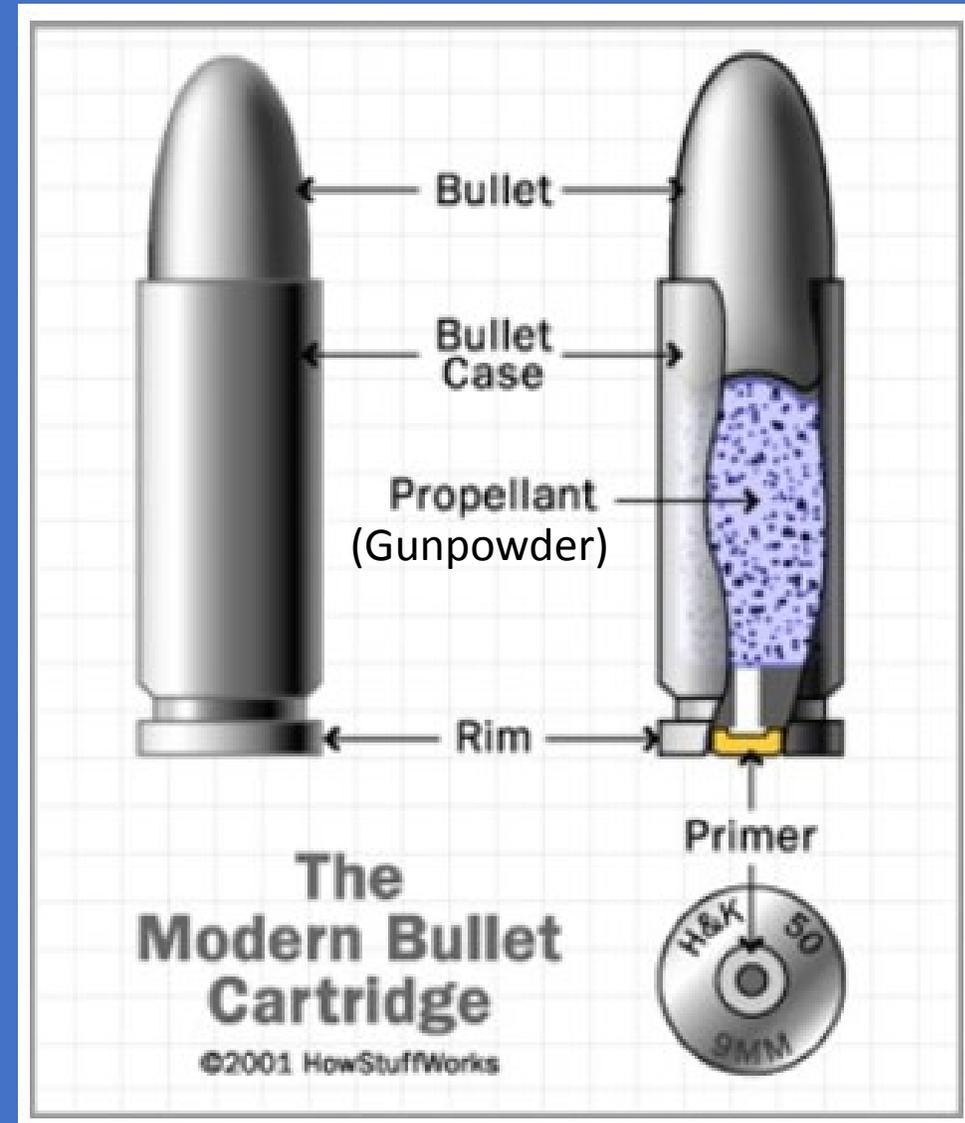
- This is called a cartridge, but many use the term "bullet" interchangeably
- As long as we know what we're talking about, it passes
- But,

Let's not push it: "Pew-pew".

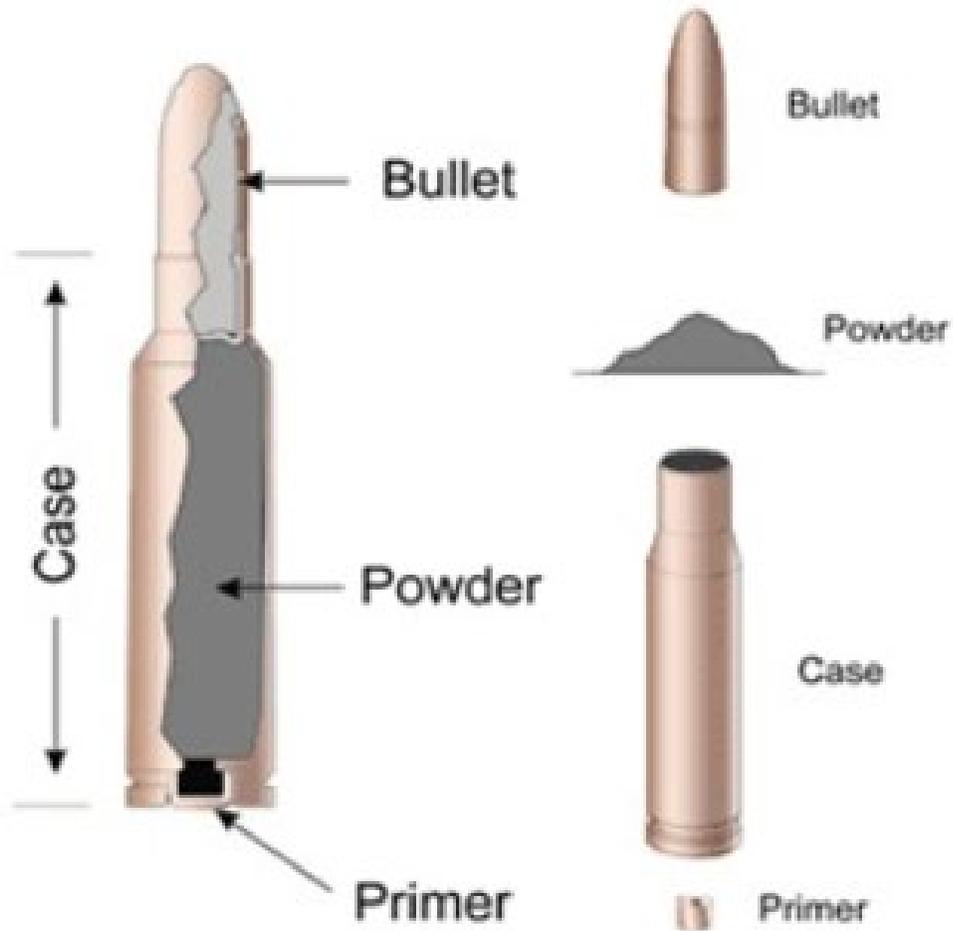


## The controlled explosion

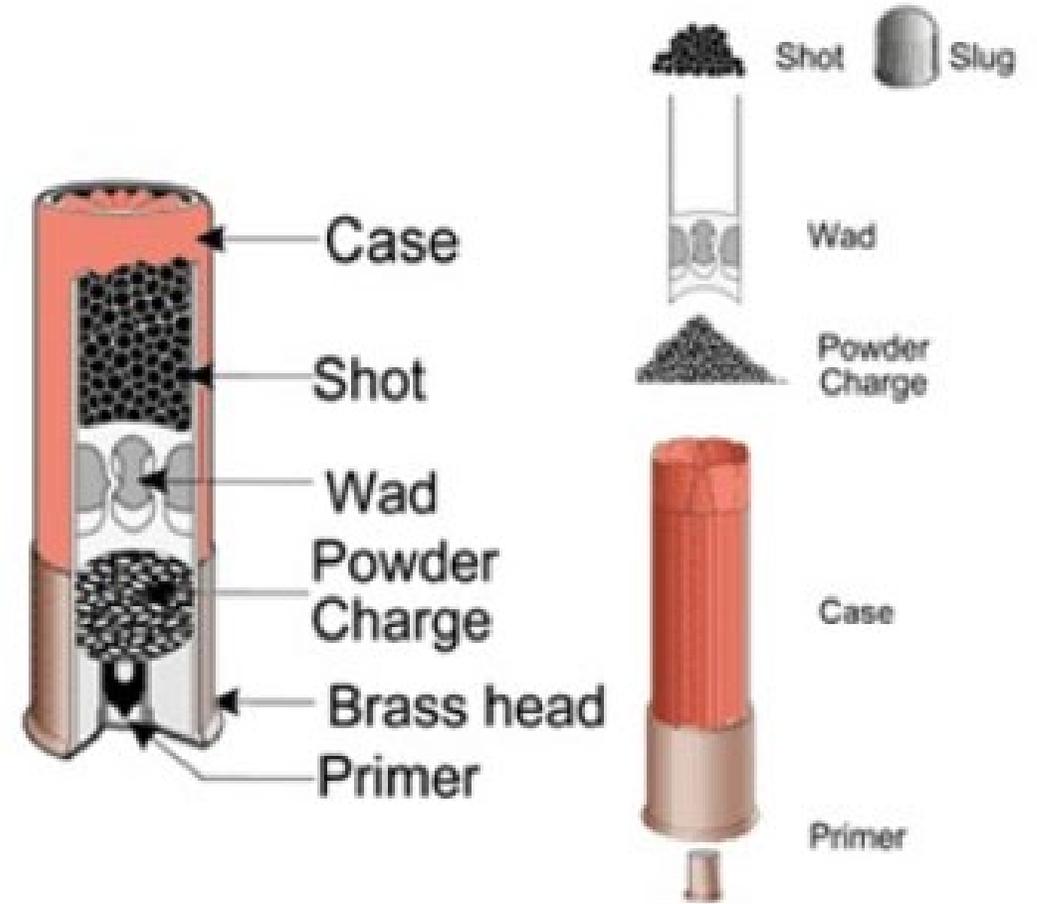
- Trigger releases hammer
- Hammer hits firing pin
- Firing pin hits primer cup on cartridge
- Primer ignites and explodes
- Propellant (gunpowder) ignites and explodes
- Sudden increase in pressure behind bullet propels it forward



## Bullet (Cartridge)

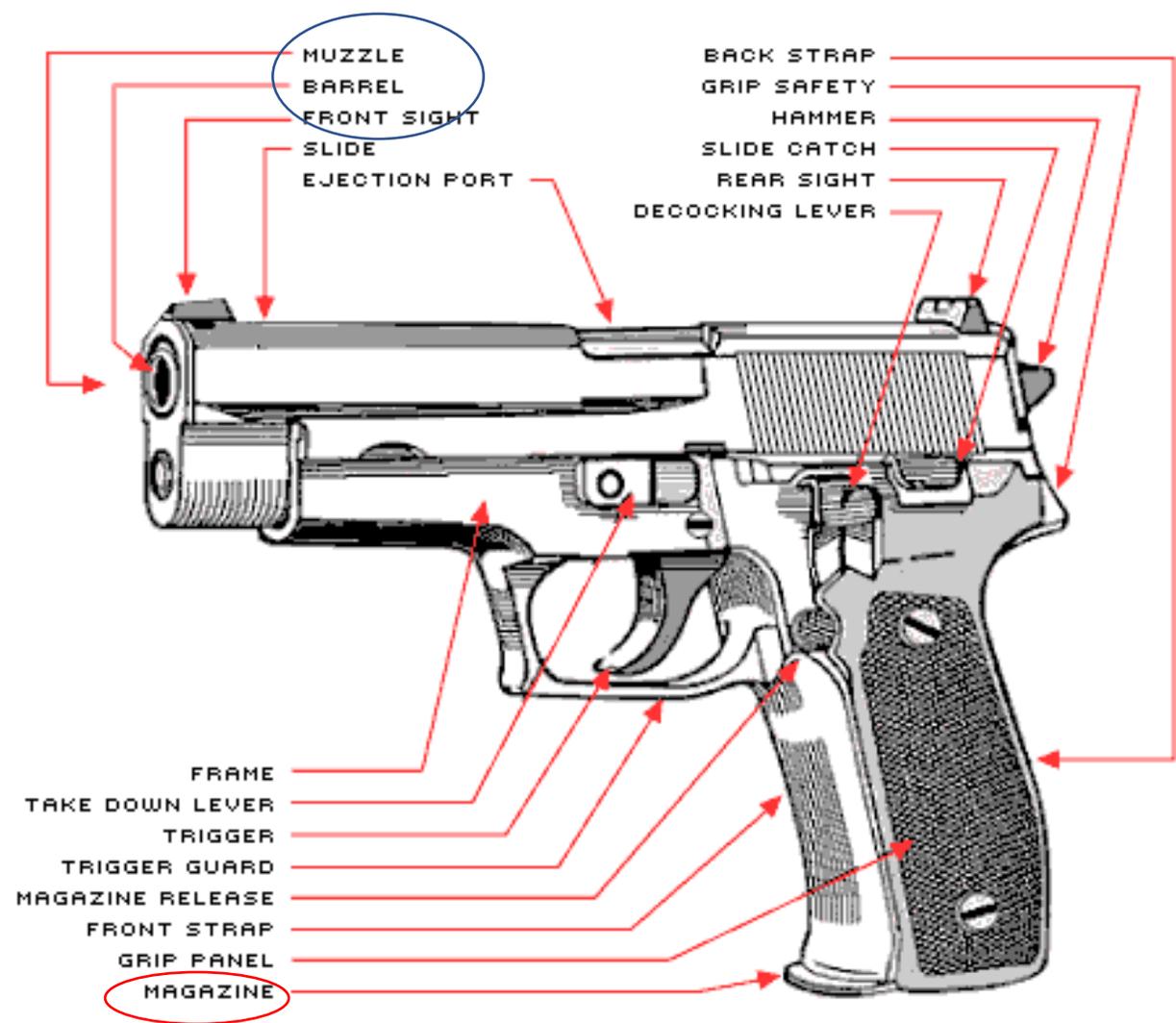


## Shotgun Shell



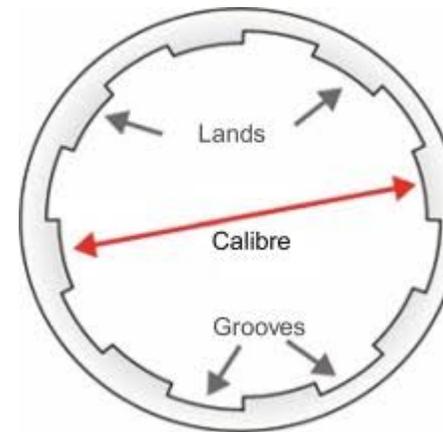
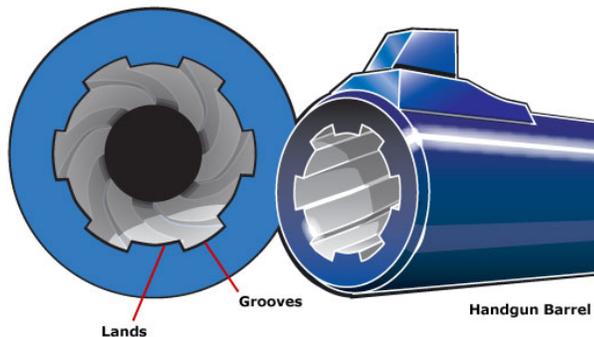
What is a “Magazine”? (“clip” used interchangeably)



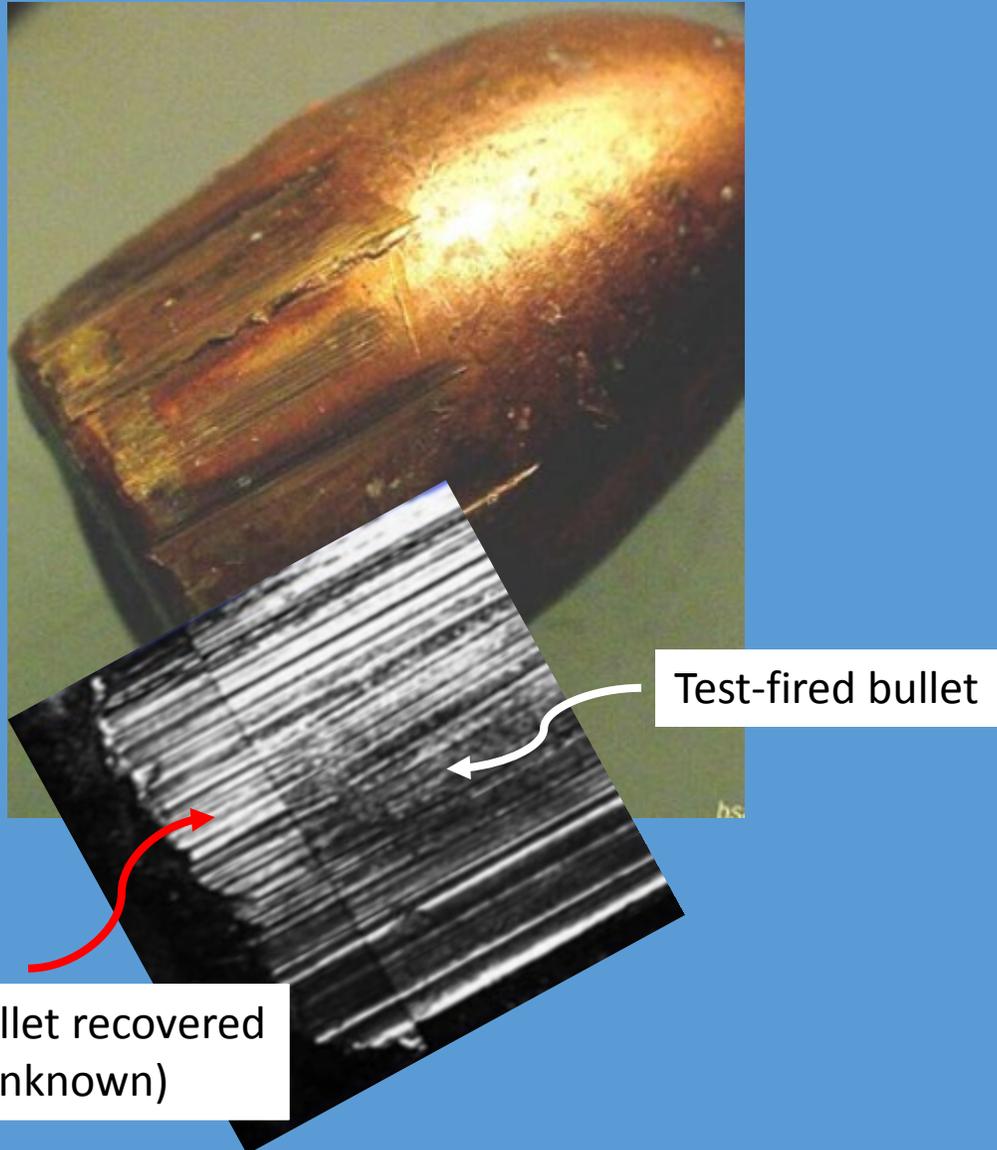


# What is meant by “rifling”?

- Shotguns basically have smooth inner surfaces
- Handguns and rifles have rifling to the inner surface
- Rifling: Spiral grooves cut into the steel to impart “spin” to the projectile (improves its flight distance and accuracy)



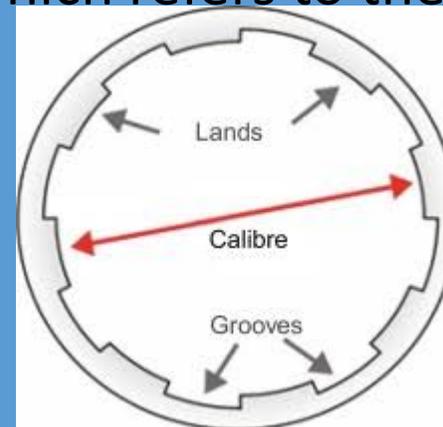
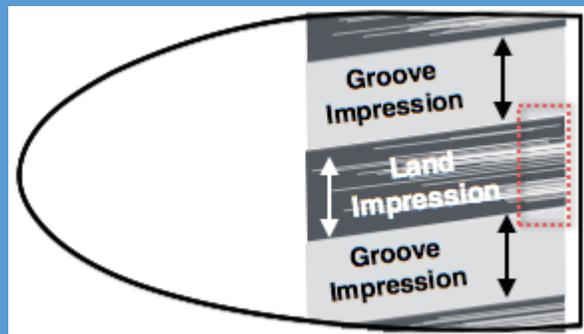
# Bullet Comparison (Crime lab stuff)



- As a bullet travels down a rifled barrel, the grooves cause the bullet to spin and **unique striations to the inner barrel** leave their marks on the bullet surface
- These are unique to the gun fired
- This is why we spend so much time collecting bullets and fragments from victims

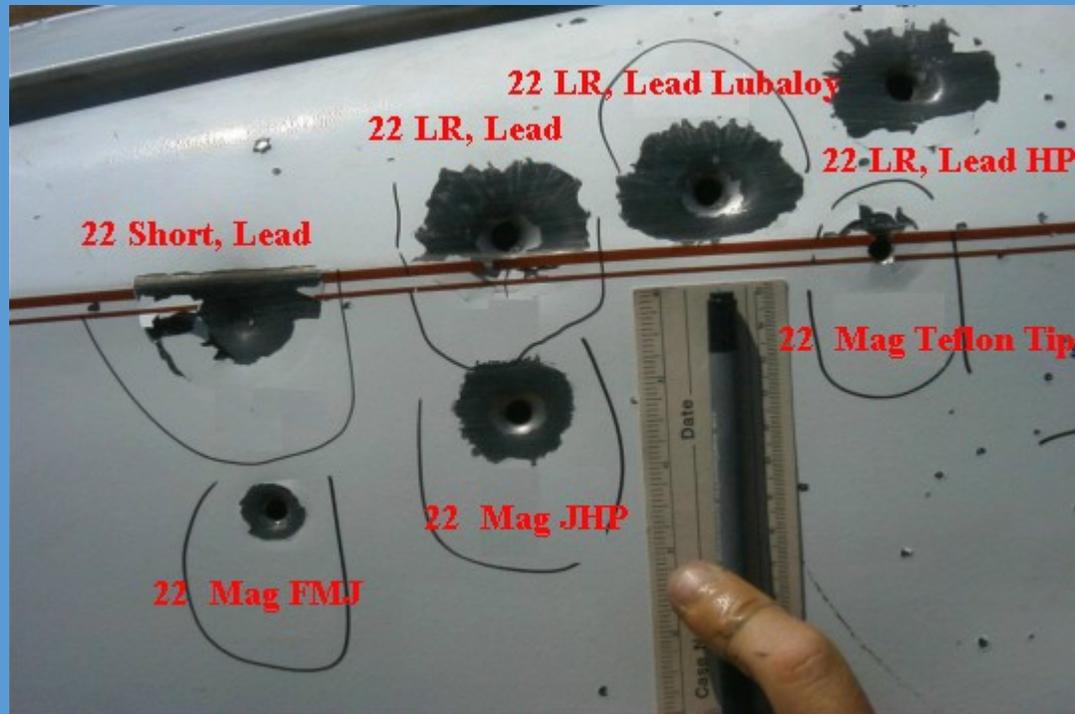
# What does “caliber” refer to?

- Caliber= the inner diameter of a barrel
  - Often recorded in millimeters: 9 mm
  - Or as a fraction of an inch: .22 caliber = 22/100 of an inch
- A shotgun barrel’s diameter is expressed in terms of “gauge”
  - The higher the “gauge” number, the smaller the diameter: 10G, 12G, 20G
  - The exception is the .410 shotgun, which refers to the diameter in inches



12G=.729 inch

# So, why aren't entrance GSWs always the same diameter as the bullet?



- We are squooshy and rubbery—skin has elasticity
- Some skin may produce slit like entrances (palms and soles)
- Desiccation of wound edges
- Bullets entering with some “yaw” (not perfectly round perforations)
- Rifle bullets often create very large entrance wounds (?why)

How do we determine range of fire from an autopsy?



# The “Pew-pew Stuff”

- Bullet
- Flame
- Soot/smoke
- Unburned and partially burned gunpowder particles
- GAS (including CO)
- Filler (in buckshot/birdshot loads)
- Shotcups, wadding (in shotguns)



# Aerodynamics of the projectile “stuff”

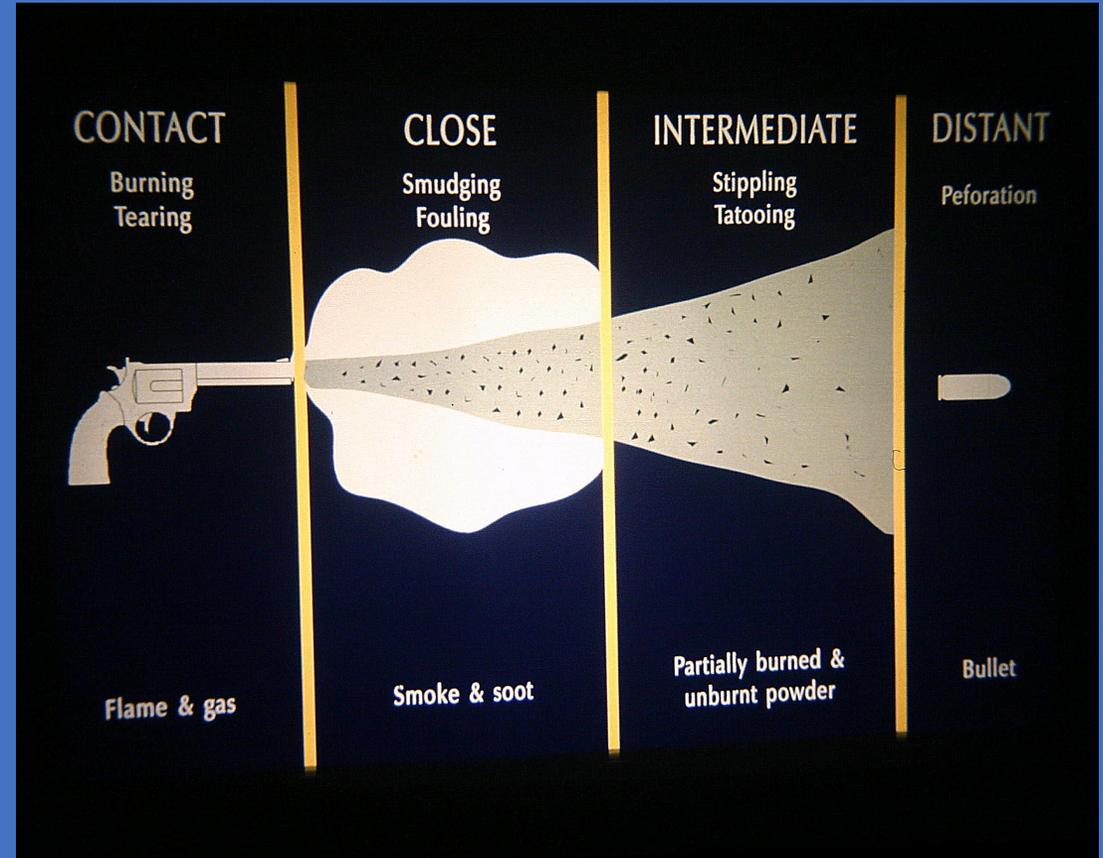
- Bullet: the most aerodynamic part, especially with the “spin” imparted to it by a rifled barrel
- Gunpowder particles: aerodynamics depends on the **shape and weight** of the individual particles
  - Flake powder (discs)
  - Flattened Ball powder
  - Ball powder (the most aerodynamic shape)
  - Cylindrical powder (uncommon in US)
- Soot (not very aerodynamic)

# Other stuff that comes out

- Metal from vaporized primer (antimony, barium and lead)
- Metal vaporized from the cartridge (copper, zinc and sometimes nickel)
- Metal left in barrel from previous bullet discharge
- Metal stripped or vaporized from the fired bullet
- Grease and oil that coated the inside of the barrel or the bullet before discharge

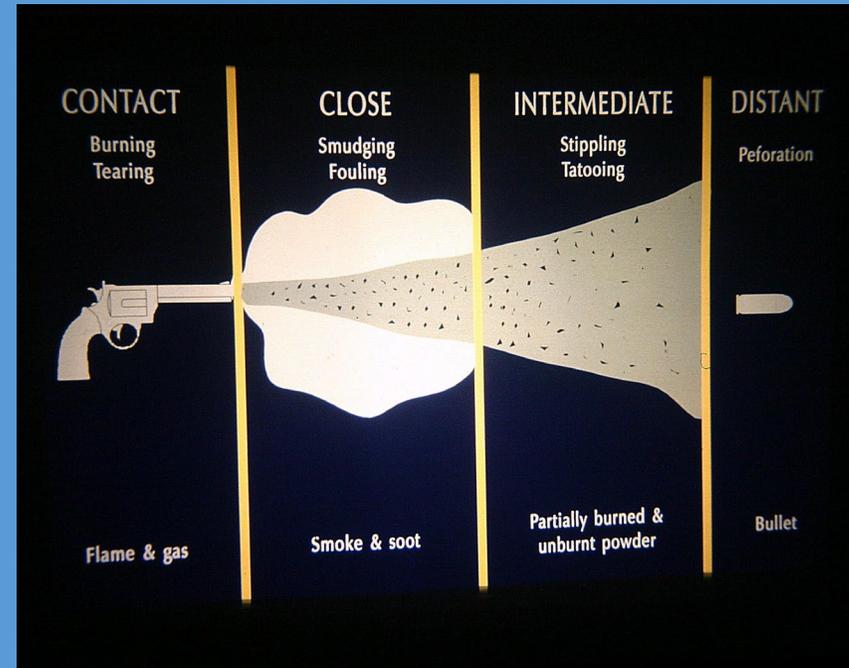
# Examination of the body of a victim may provide information about the distance of the muzzle from the skin surface

“Range of fire”



At increasing distances, the aerodynamic potential of the various projectile “stuff” leaving the barrel is lost

- At a particular distance, the “stuff” in question either:
  - **Enter** the body with the bullet
  - **impacts** the surface with sufficient energy to create **injury**,
  - impacts the surface and visibly **adheres** to the skin
  - dissipates to the point that it is not visible on the skin
  - **falls short** of the target

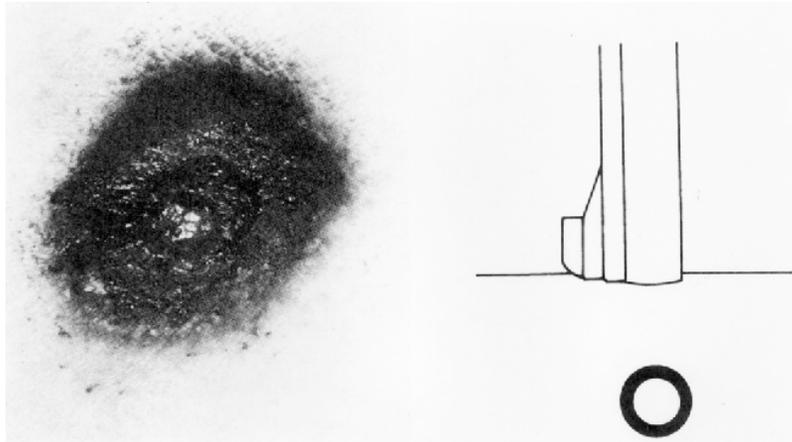


# Contact Wounds: muzzle stamps, searing, soot, gas and gunpowder

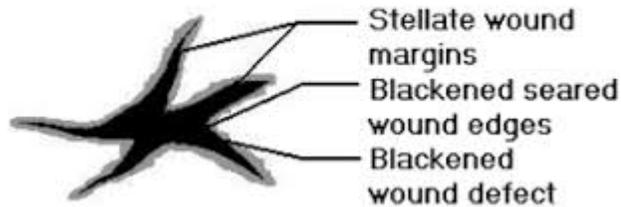


# HARD Contact vs. LOOSE Contact

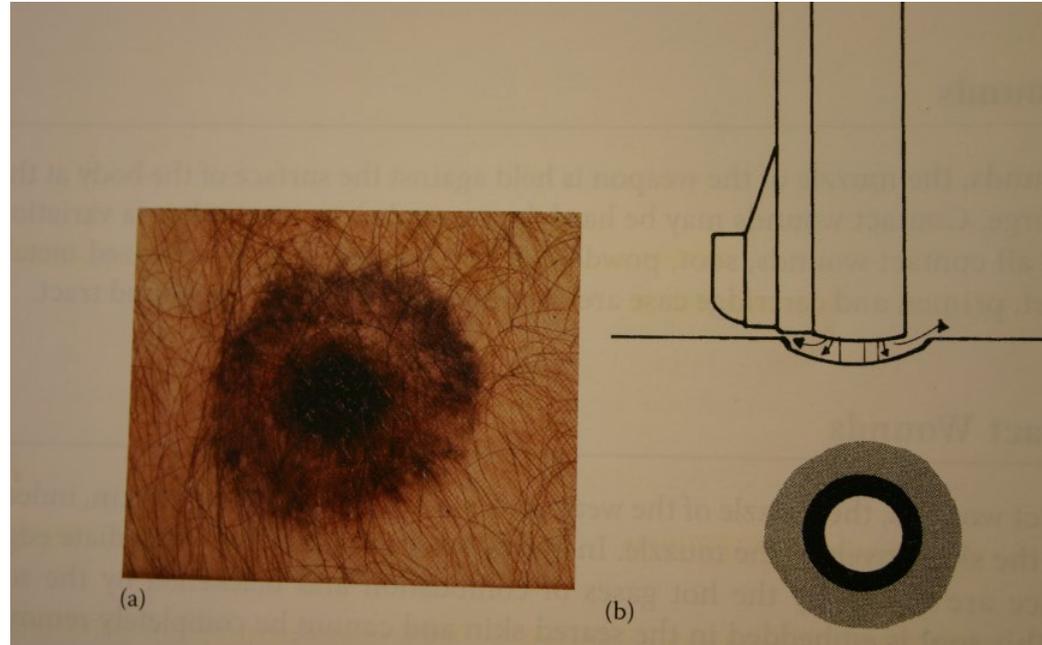
- HARD CONTACT



Contact entrance wound over bony area



- LOOSE CONTACT



(a)

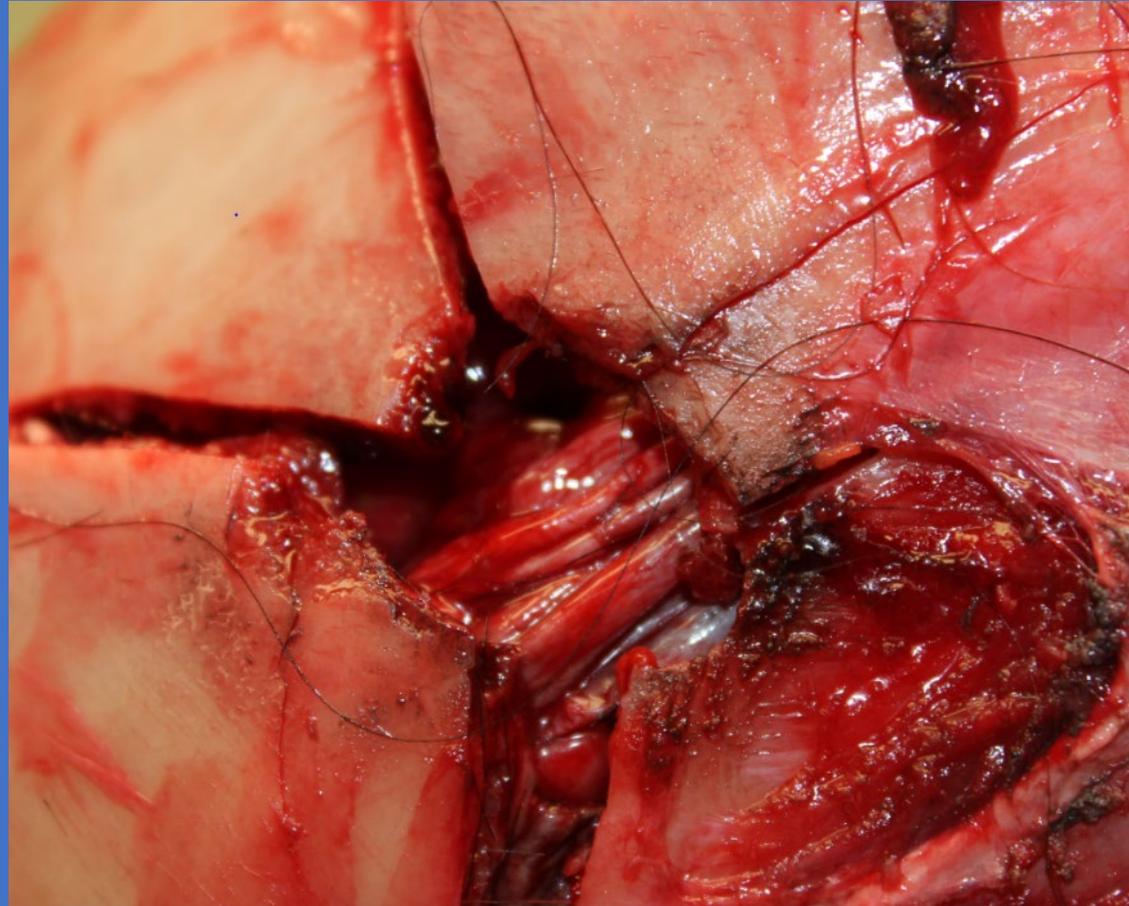
(b)

# Contact GSW to head with muzzle imprint

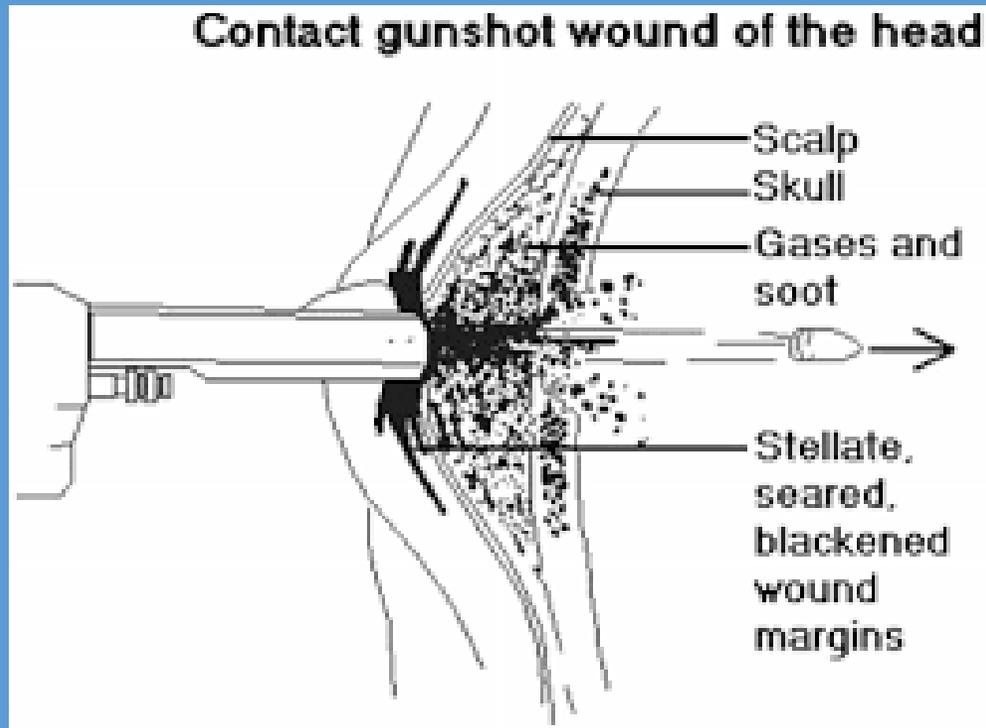


This is one reason we like to examine the alleged firearm at the time of autopsy

Soot to surface of underlying skull



With contact wounds, the appearance of the entrance wound depends on the location

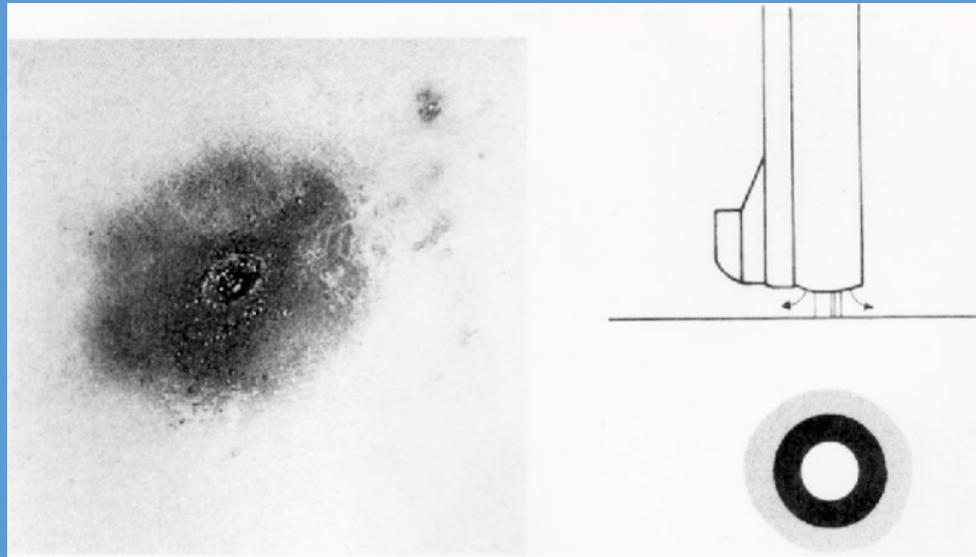


# Loose contact

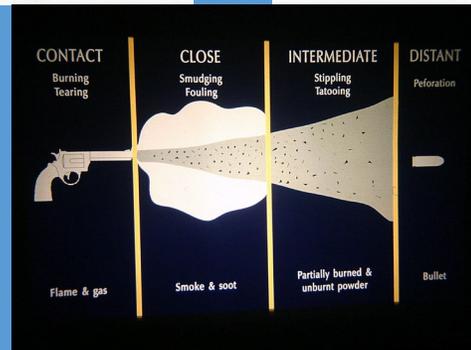
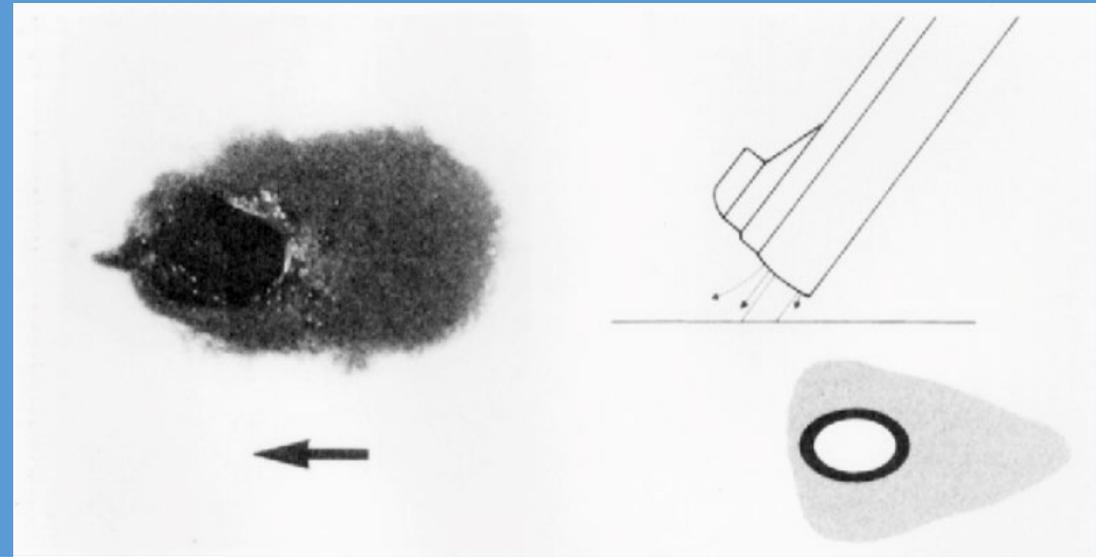


# NEAR Contact

- NEAR Contact



- NEAR Contact ANGLED



NEAR CONTACT GSWs

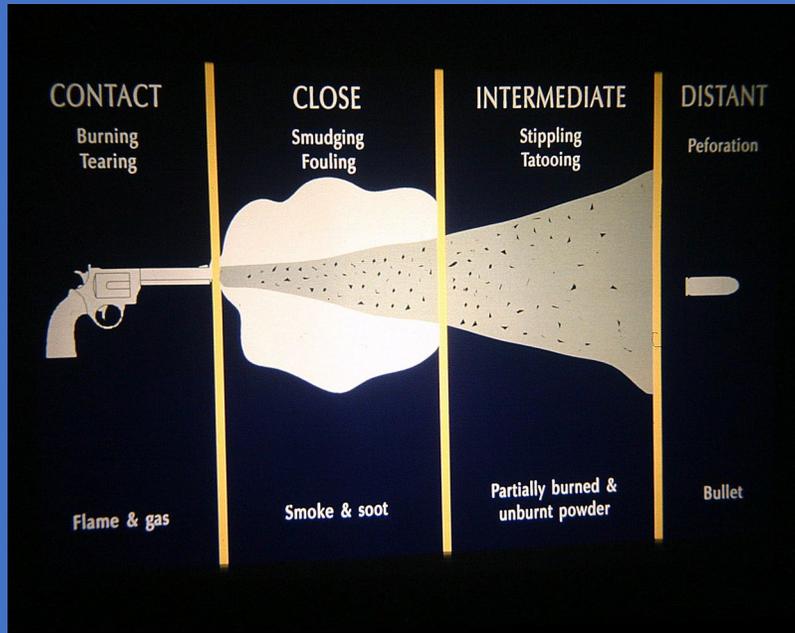


Wide ring of soot  
around Gunshot  
Wound Perforation

# Intermediate range GSWs: “Gunpowder Stippling”



# Gunpowder stippling



# 2 GSWs to the head



# To what distance is soot deposition and gunpowder stippling seen?

## **SOOT**

- For most handgun cartridges:  
Typically absent beyond 30cm  
(12 inches)

## **Gunpowder stippling**

- Depends on the caliber of weapon and the powder type, as well as the barrel length, the individual weapon and the presence of intermediary targets
- Max distance of 3 ½ feet reported using a .38 special w/ ball powder

# Gunpowder Stippling:

- Must use caution in opining about range of fire
- Test-firing the weapon (firearms examiners) may assist in determining range of fire in some cases
  - If it's that important that you know the distance down to a 6-12 inch range, you should be asking a firearms examiner.

# Intermediate range: test firing of weapon

9 inches



15 inches



27 inches



# What about rifles and Shotguns?

## Rifles

- The amount of soot is typically less than that seen from handguns (length of barrel)
- Gunpowder stippling is dependent on the type of powder and rifle (30-36 inches in some combos)

## Shotguns

- Deposition of soot is typically absent beyond 30 cm (12 inches)
- Stippling depends on gunpowder used

# “Indeterminant range” GSWs



Does Indeterminant range mean “distant”?

# Indeterminant range $\neq$ “distant”

- Is it possible that something got in the way of the “stuff” exiting the barrel?
  - Intermediary targets (doors, pillows, other people, etc.)
  - Clothing
  - Hair
  - Other body parts (arms/hands—re-entry wounds)

While we're at it: Does "Stippling" always =  
"intermediate range"?

Irregular perforation shape, atypically wide abrasion and odd stippling

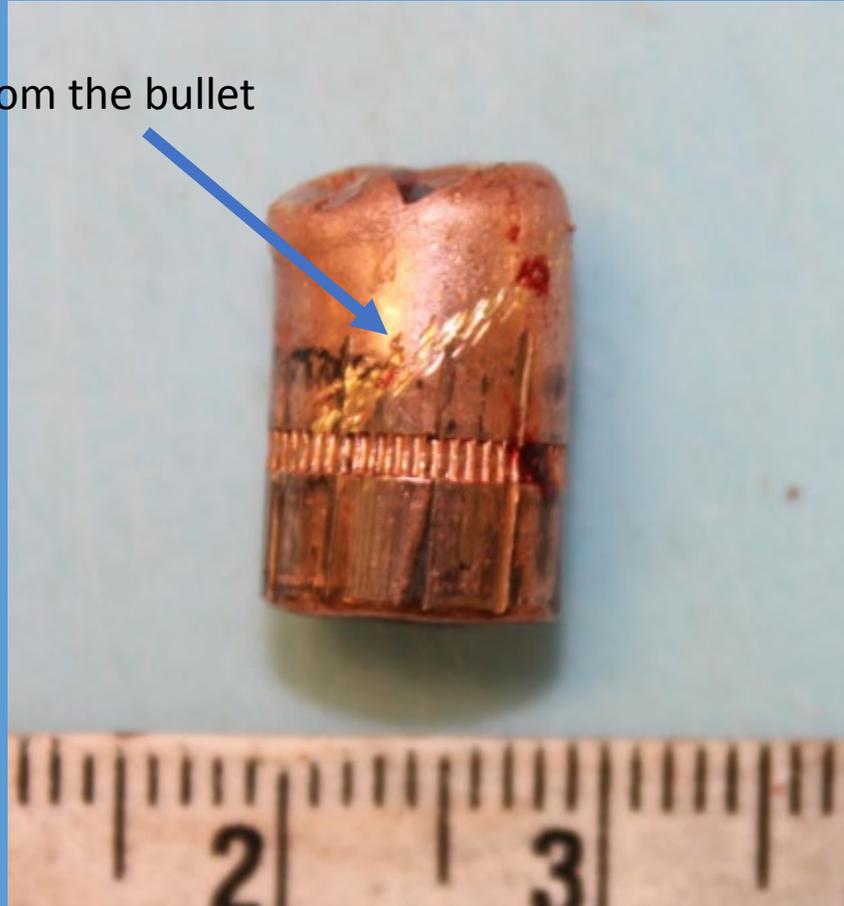


# 2 entrances

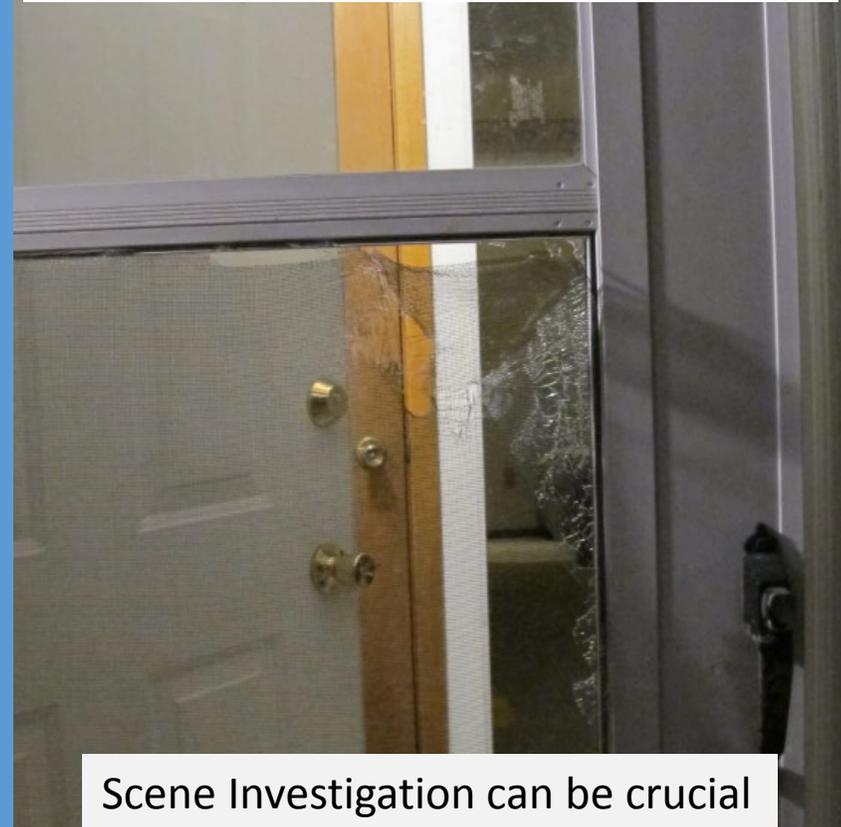


This is not gunpowder stippling, but stippling from broken glass (“pseudopowder tattooing”)

A clue from the bullet



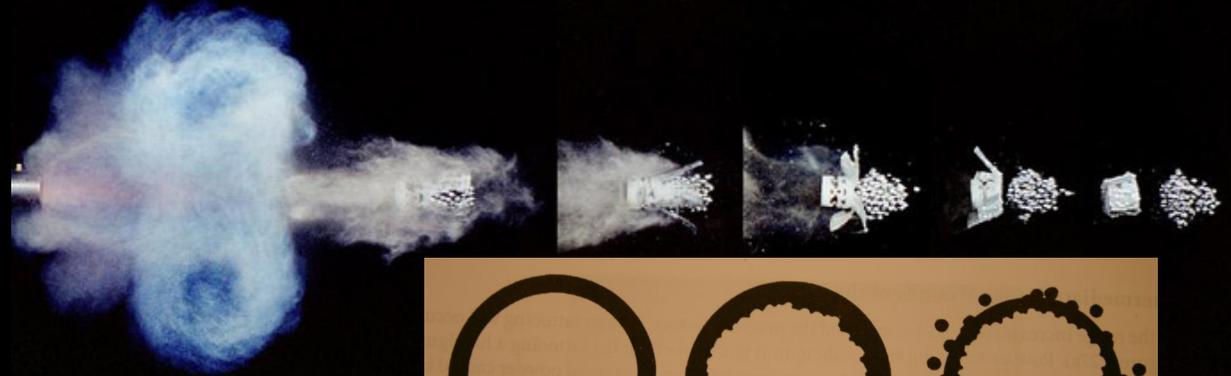
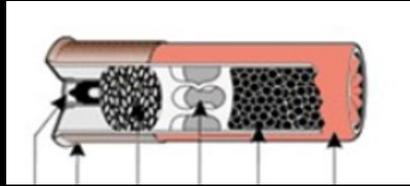
Don't forget about **intermediary targets**



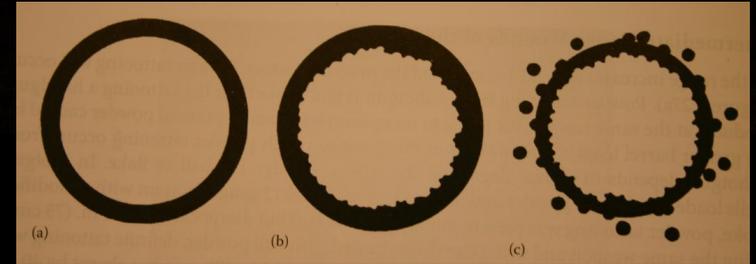
Scene Investigation can be crucial



# Range of fire: Shotguns



- At short distances, the pellets stay together, spreading out with greater distance
- Shotcups and wadding in shotgun shells also travel a distance (may enter wounds, abrade the skin around wounds, or fall away before reaching body)
  - Petal marks between ~1-3 ft, drift laterally between ~5-8 ft
  - Max range wads produce injury?? 20ft or more possible



# Why is it important to examine clothing?

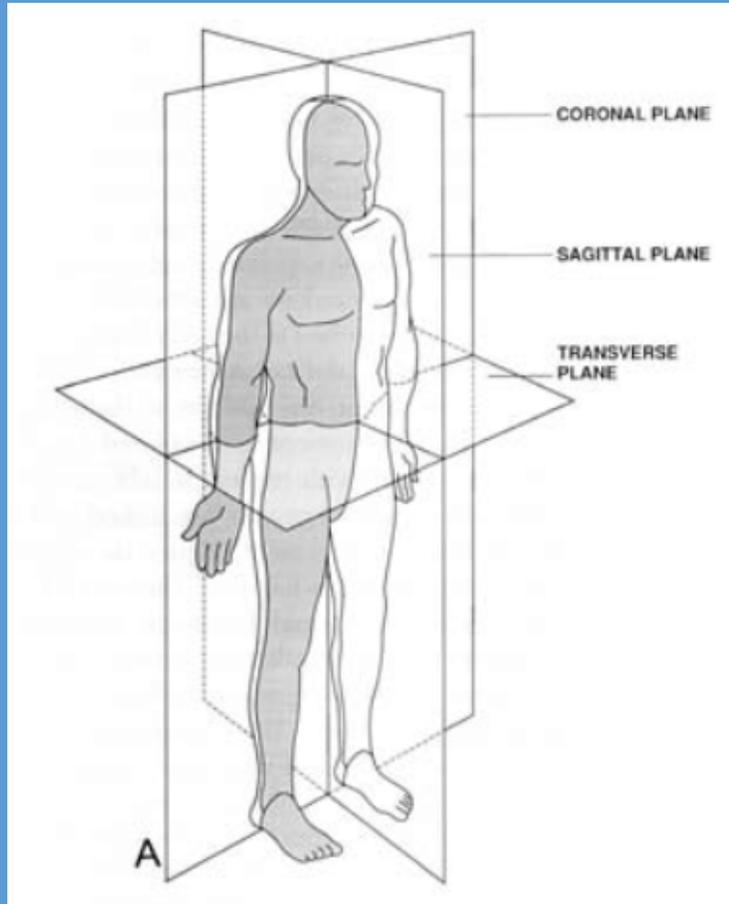
- “stuff” from the barrel can deposit on clothing
- May be difficult to see with the naked eye, depending on the color and fabric type
- Some gunpowder particles can pass through clothing under the right circumstances



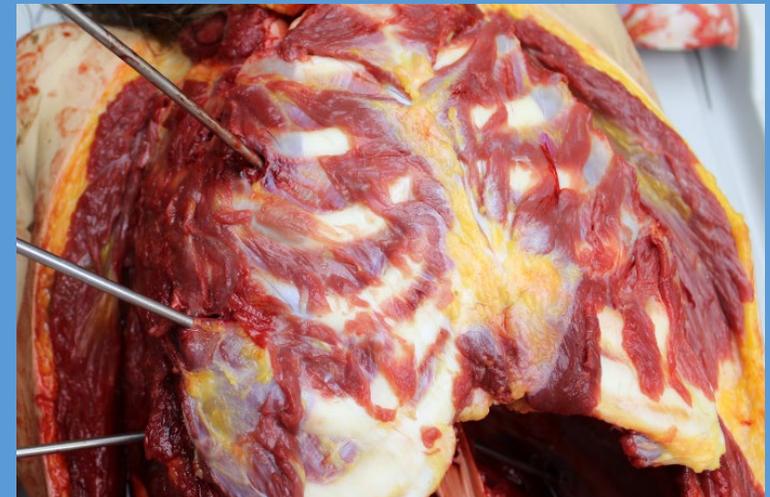
Gunpowder with some kinetic energy vs. intermediary targets (secondary missiles)



# How do you determine trajectories and what is the “anatomic position”?



- Sometimes trajectories don't line up in straight lines unless the body is bent at angles, twisted, etc.
- But that is typically noted in the report





Time allowing...

GSW injuries: more than just tunnels through the body



# What actually causes the injury to the body from GSWs?

- Kinetic Energy
- $KE = \frac{1}{2}mv^2$
- So, if you double the mass of the projectile, you double the KE
- But, if you double the velocity, you quadruple the KE



# How fast do bullets travel?

- .25 Auto=760 ft/sec
- .45 Auto=855 ft/sec
- 9mm Parabellum Auto=1299 ft/sec
  
- .38 Special revolver=755 ft/sec
- .44 Magnum revolver=1350 ft/sec
  
- 7.62 x 39 rifle=2300 ft/sec
- 5.45 x 39 rifle=2945 ft/sec

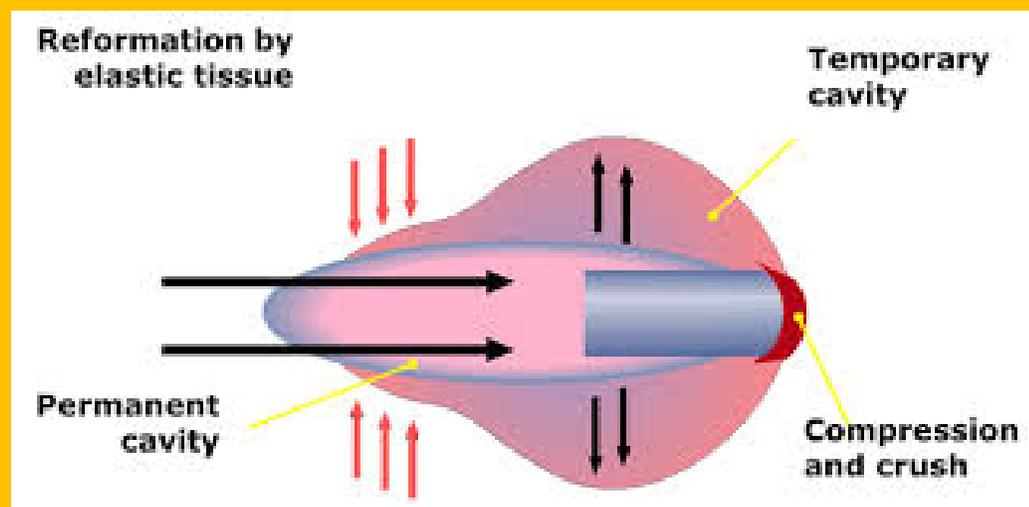
**Miller Park:** 400 feet from home plate to center field

**Lambeau:** 300 feet goal line to goal line

# So, it's the amount of kinetic energy the bullet possesses that causes the damage?

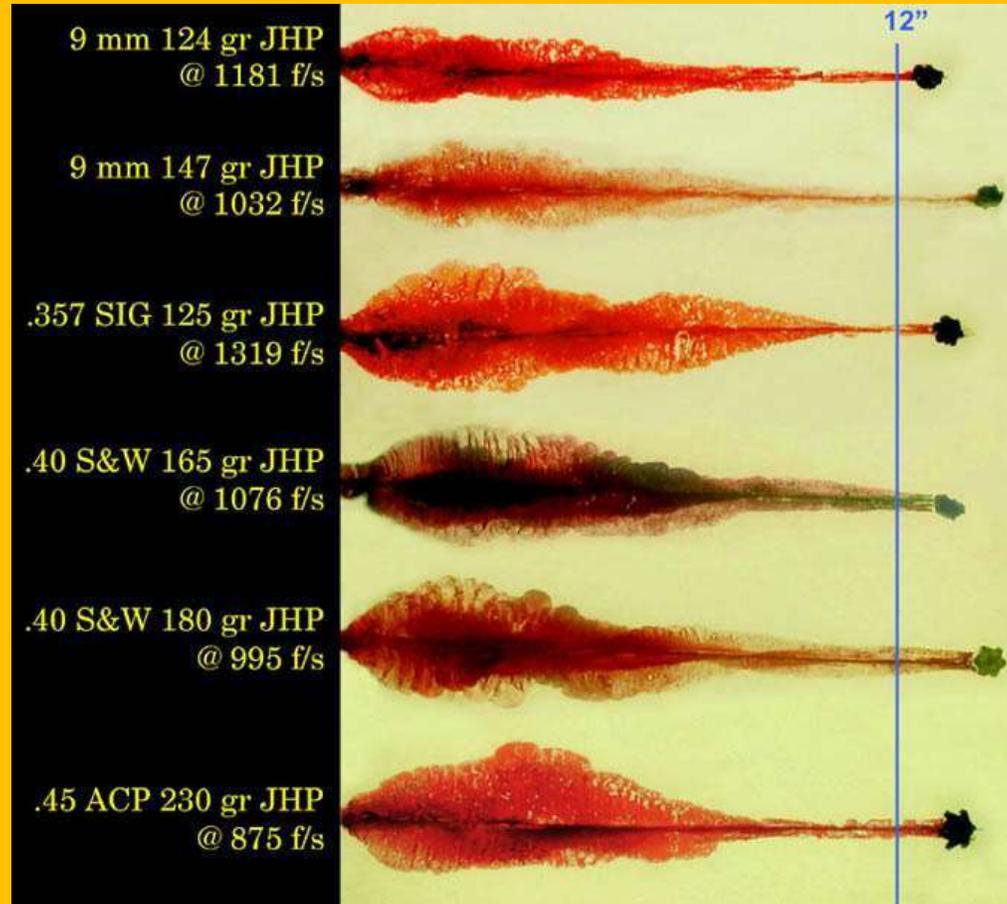
- Not exactly.
- It's more accurate to say that the damage is dependent on the amount of kinetic energy that is lost to the tissues
- This depends on:
  - Bullet shape
  - The yaw of a bullet (the angle from perpendicular)
  - Change in the bullet's "presented area" before or after entering the body
  - Bullet construction
  - The type of tissue the bullet passes through (elasticity to resist deformation by temporary cavity)

# “Temporary Cavity”?



- As the bullet passes through the body: the tissues are displaced radially creating a temporary cavity
- The size depends on the amount of kinetic energy absorbed by the tissues
- Velocities in the range of 2600 ft/sec (rifle bullets) create kinetic energy in excess of what most tissues can handle, resulting in temporary cavities up to 12.5 times the diameter of the bullet
- The temp cavity then collapses back to the size of the permanent cavity

# Temporary cavities



# What do we know about “backspatter”?

- Backspatter: the ejection of blood and tissue from an entrance GSW
- Tissues may be ejected from entrance wounds as well as exit wounds due to the pressures created within the wound cavity
- How far??

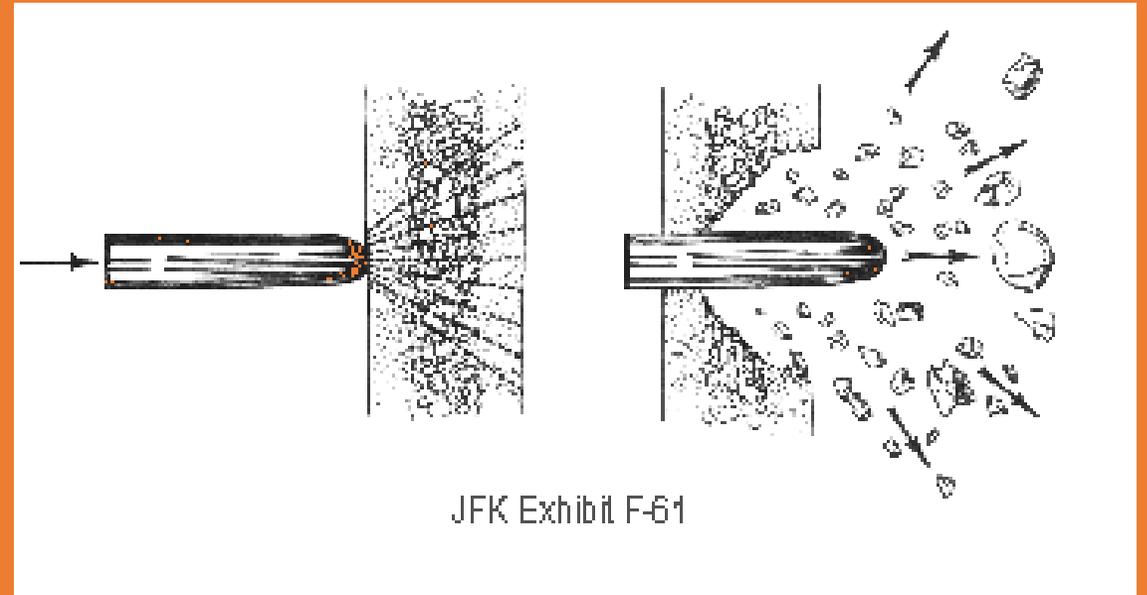
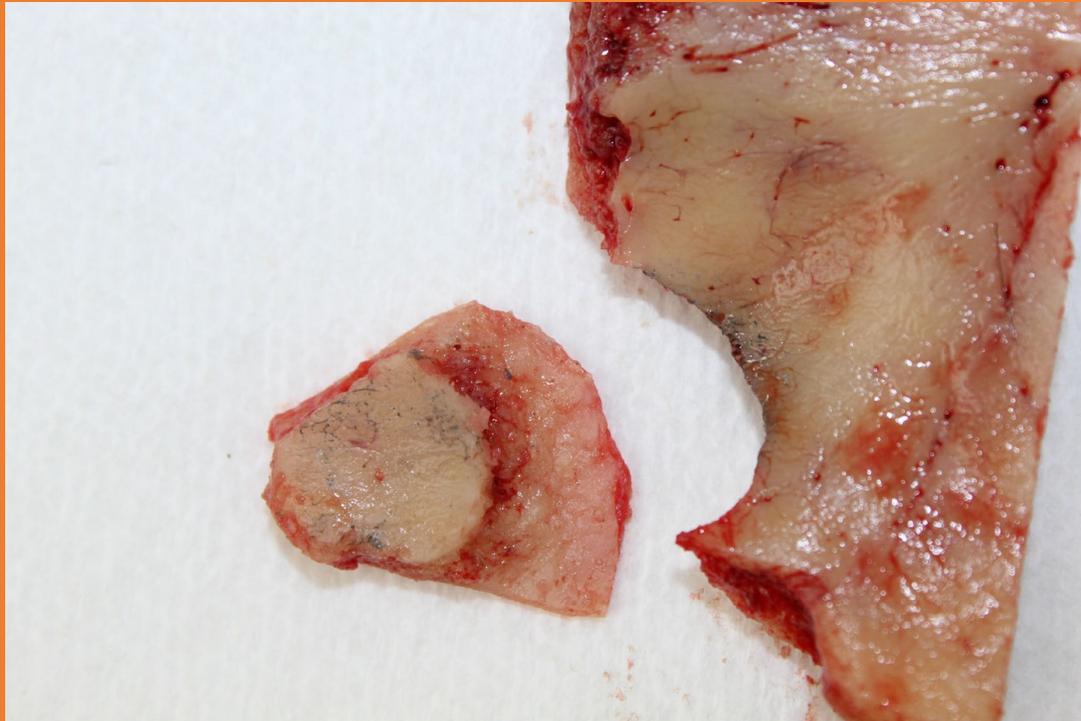


# How can you tell an entrance wound from an exit wound?

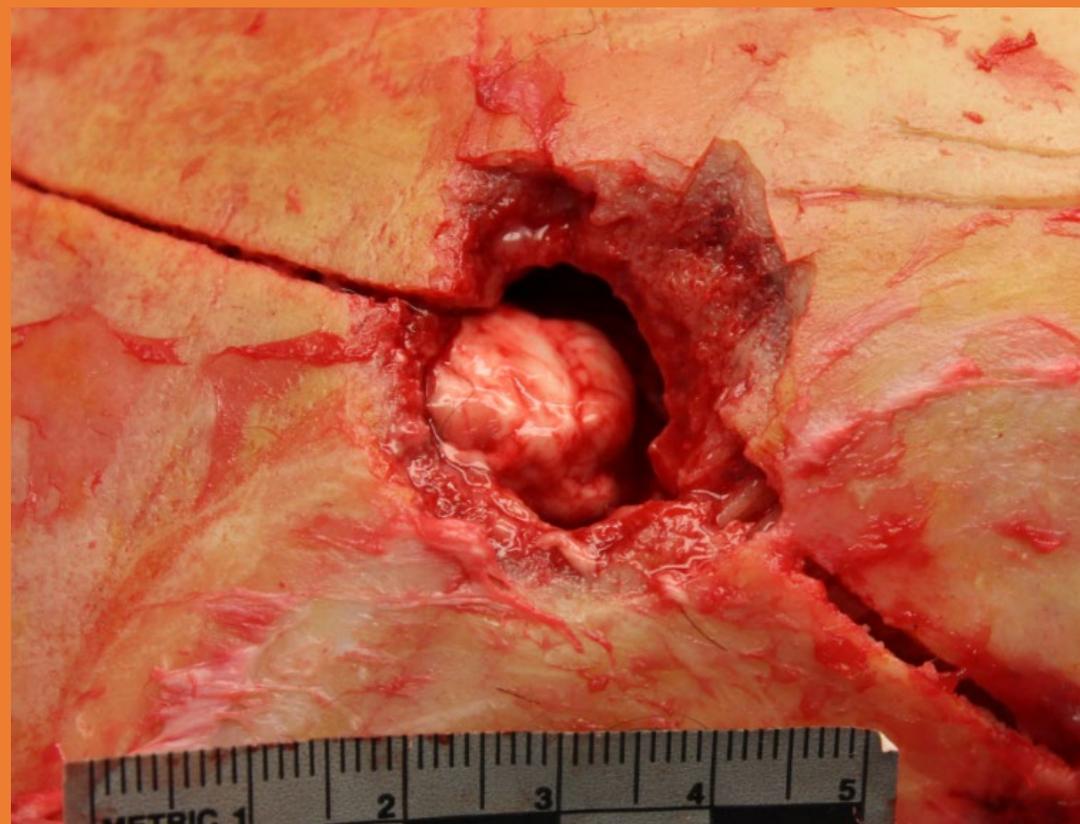
- **Caution:** Non-FP physicians get it wrong not infrequently and it ends up incorrect in the medical record
- Entrances: usually clean, punched out margins with a circumferential abrasion collar
  - Entrances not always small and round (re-entry wounds)
  - Entrances don't always have abrasion collars (palms, soles, elbows)
- Exits: usually slit like or “tears” to the skin
  - Exits not always large and irregular though
  - Abrasion can be seen around exits (shored exits)



In GSWs to the head, the skull can help with entrance/exit determination



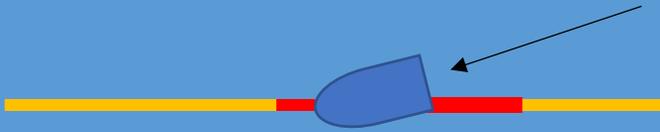
# Entrance and exit perforations to the skull



# Medical Intervention can introduce artifact to wounds

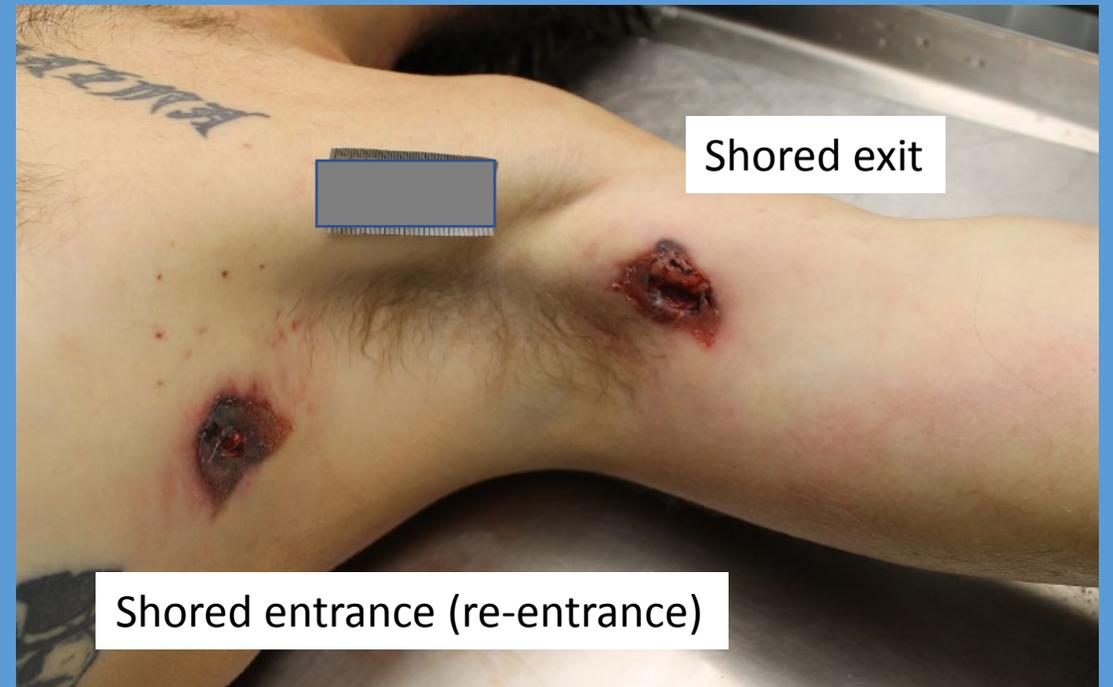
- Incisions made through wounds
- Tubes inserted through wounds (chest tubes)
- Wounds explored or packed
- Wounds surgically closed
- Cleansing of wounds may remove soot
- Surgical repairs may obscure trauma to organs and tissues

# Entrance wound with accentuated abrasion



# Re-entry wounds

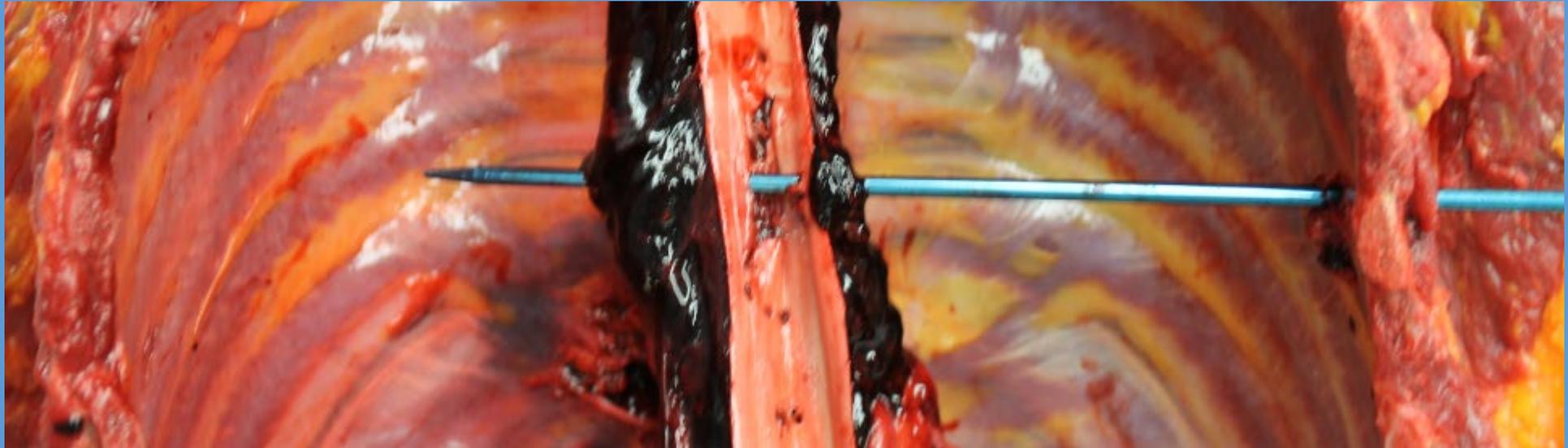




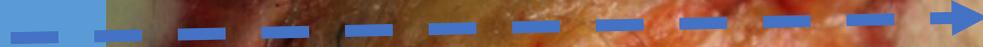
Re-entrance wound



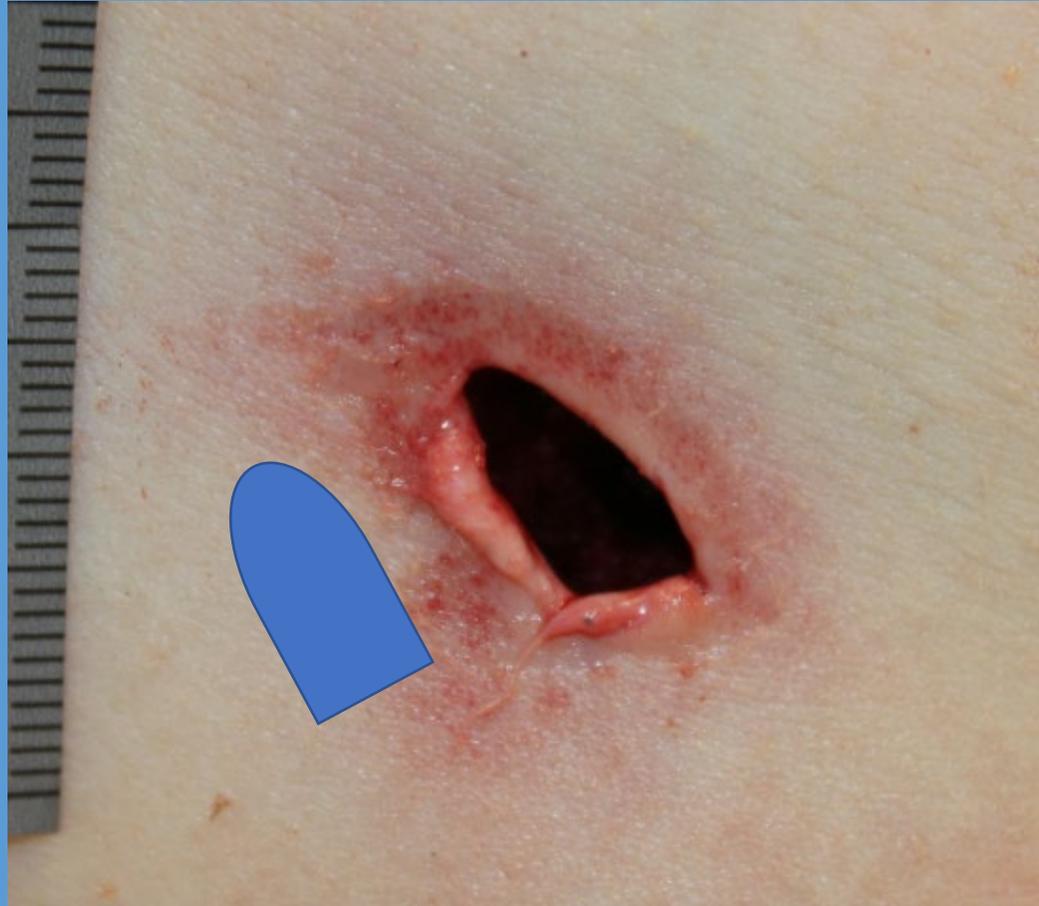
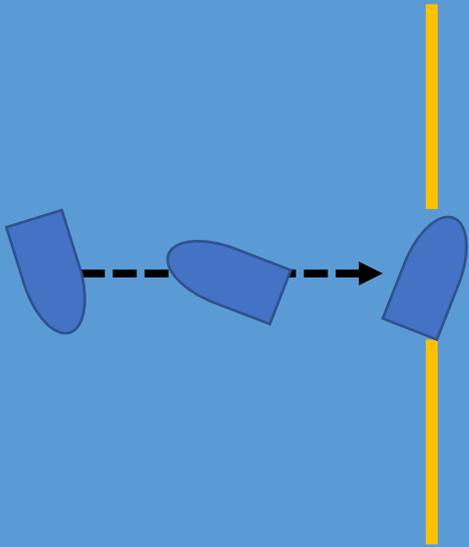
The “intermediary target” didn’t absorb that much energy though



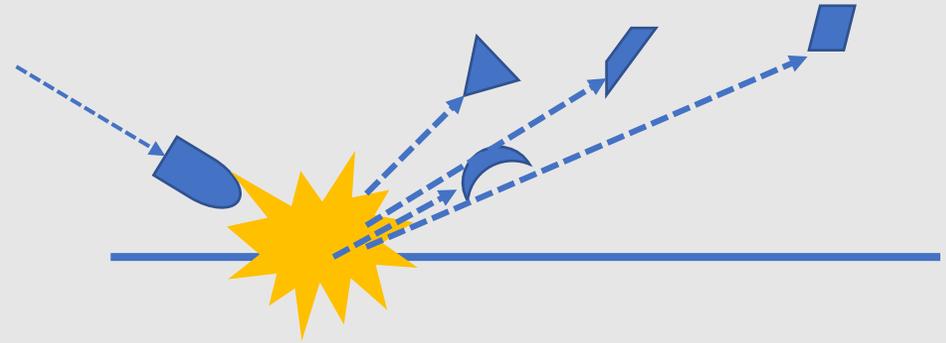
# Graze wounds



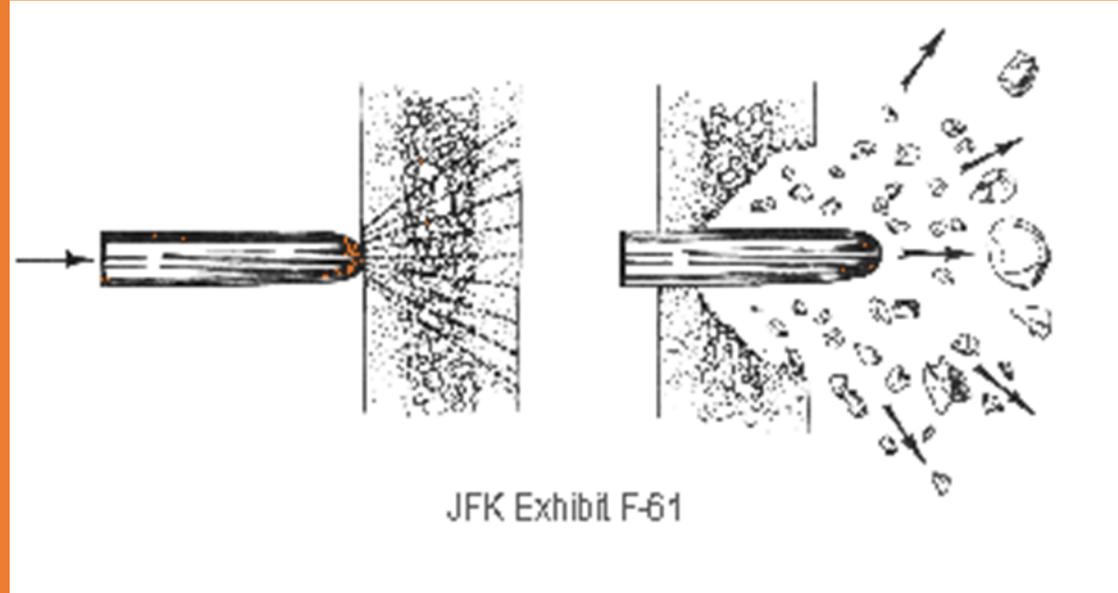
Yaw: the wobbling/tumbling bullet



# Ricochet bullets



# Secondary Missiles



What is the injury to the chin?



# Secondary missiles



- Bone fragments

Questions?