

Wound Ballistics

Explaining the interactions between
penetrating bullets and vivid tissue

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Current knowledge an introduction to wound ballistics

- ▶ The only scientific sphere directly addressing the incapacitation power of cartridges and hunting bullets is wound ballistics
- ▶ Ballistics is in general the science of bodies in flight
- ▶ Applied to bullets, this discipline is divided into 4 categories
 - I. Interior ballistics – the study of bullet acceleration, motion and related processes in the barrel
 - II. Intermediate ballistics – the study of influence on bullet flight from the weapon after departure from the muzzle
 - III. Exterior ballistics – the study of bullet flight between the escape of the influence of the weapon and the moment at which the bullet strikes its target
 - IV. Terminal ballistics - the study of forces, deformation history and motion of a bullet penetrating a medium (the target) denser than air

If the target consists of living tissue, we speak of Wound Ballistics

Current knowledge an introduction to wound ballistics

- Wound Ballistics aims to describe the interactions between projectiles penetrating tissues and the damaging effect of projectiles on tissues
- Few professional disciplines require such knowledge and those generally involved are military personnel, forensic investigators and surgeons treating tissue affected by bullets
- The knowledge of hunters and wildlife management is hence frequently based on collective consensus developed from common experience, manufacture-provided information, myths or insubstantial contentions from popular periodicals

Current knowledge an introduction to wound ballistics



We must also make a clear distinction between primary and secondary effects of penetrating bullets

- I. Primary effects are those caused directly by the projectile
- II. Secondary effects are those resulting from the primary effects but occurring much later such as:
 - Blood pressure changes
 - Hormone production
 - Pathological changes



This presentation regards only primary effects as secondary effects are not a topic in wound ballistics

So – why does an animal die when hit by a bullet?

-  Destruction of the brain
-  Destruction of the spinal nerve in the neck will almost instantaneously result in sudden incapacitation, but not necessarily death if no large blood veins are cut. Even if nervus vagus is cut breathing may continue for 3-4 minutes before the animal will die
-  A bullet with adequate penetration, leaving a sufficiently large permanent cavity, in vital organs will inflict incapacitation and fatal haemorrhage resulting in death to an animal

Mechanisms behind bullet wounding

-  **Penetration:** The depth a bullet seizes at in a body
-  **Permanent cavity:** The permanent hole left in tissues after the bullet has seized or left the body
-  **Temporary cavity:** The penetrating projectile accelerates tissue radially and stretch it to form a temporary pulsating expansion of the permanent cavity
-  **Extravasation:** Area where tissue it self is not macerated, but where some sensitive parts of it are destroyed (for instance capillaries)
-  **Fragmentation:** Fragments from the penetrating projectile or secondary fragments from crushed bones are impelled into the surrounding tissues. This extends the permanent cavity

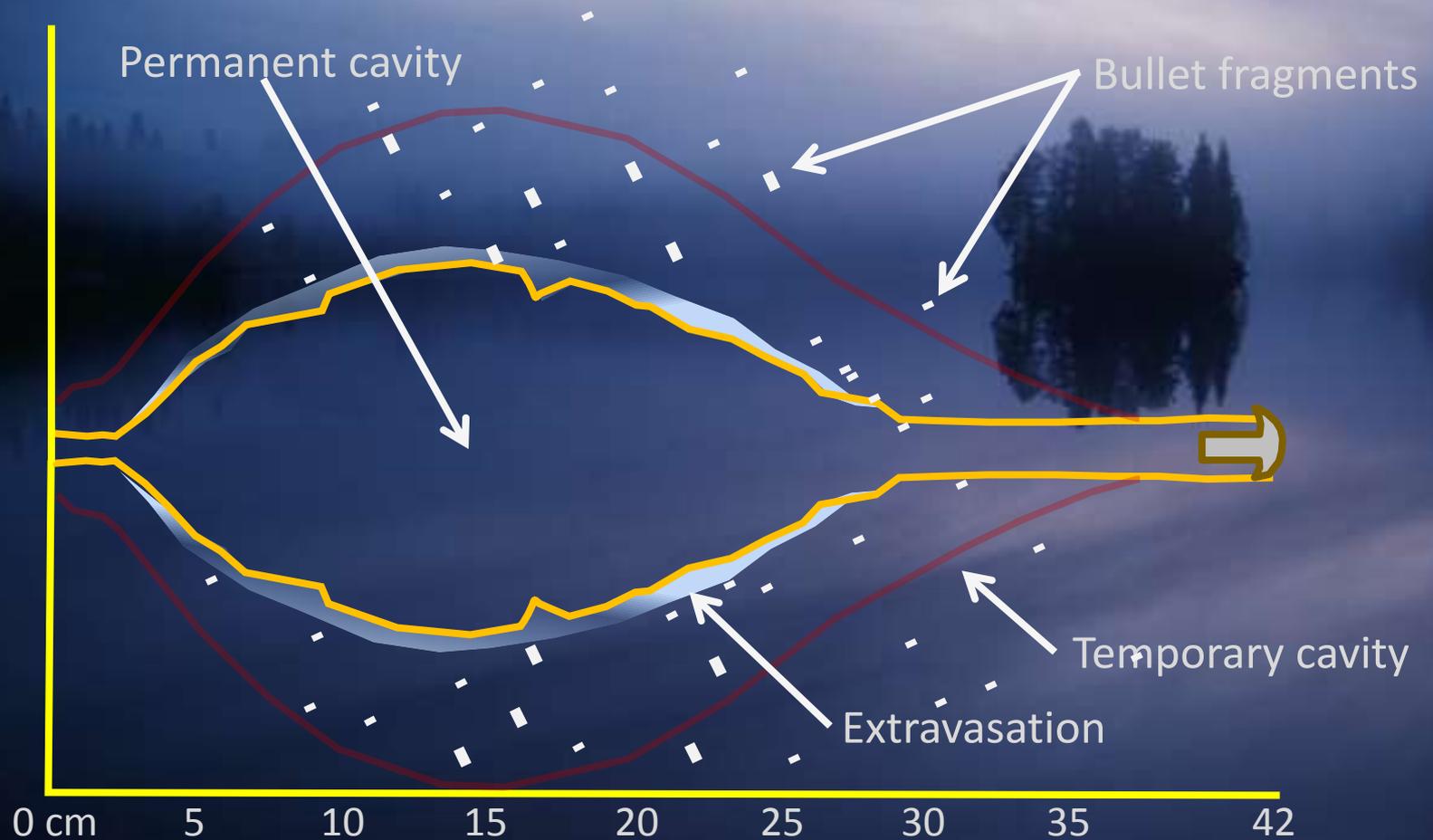
Cavitations due to bullet penetration

What kind of cavitations are we talking about?

Let us take a look at a Barnes TSX 30 cal. Bullet penetrating ballistic gelatin



Cavitations due to bullet penetration



Cavitations due to bullet penetration

- Energy transfer to the tissue is not correlated with tissue damage
- Several components of bullet-tissue interactions convert energy but do not inflict tissue disruption
- Tissue damage is done by tearing and crushing due to stress (force per area)

Cavitations due to bullet penetration

- Tissue damage depends strongly on tissue strain relative to its elastic limit (Young's modulus)
- Thus, the following factors will modulate the size of the damage
 - I. The magnitude of the energy being stored in the tissue (a function of bullet drag force)
 - II. Tissue type and sensitivity to strain
 - III. Anatomic constraints on tissue movement
 - IV. Size of the tissue structure (organ or body)

The concept of shock and remote effects

-  There is no common agreement regarding the possibility that bullets can cause distal injuries in a body
-  However, it is important to distinguish between shock waves on the one hand and mechanical pressure waves on the other
-  A mixing of these two completely different waves is probably the main reason for the controversy regarding the nature of remote shock effects

Shock wave

☑ A shock wave is an acoustic wave where particles are forced to oscillate around a rest position by a sudden and aperiodic stimulation. Notably, **no substance is transported** by such a wave, but **pressure** is

- Two spherical shock waves are seen, one centered about the gun's muzzle (the muzzle blast) and a second centered on the cylinder. The supersonic bullet is visible at the far left

Pressure waves and remote effects



In tissue mechanical pressure waves arise with translocation of substance in a wavelike motion due to pulsation of the temporary cavity



Immediate incapacitation can thus occur due to indirect CNS tissue damage

Thank you for
your attention