Nasser El said FRCS

Chief of vascular surgery department.

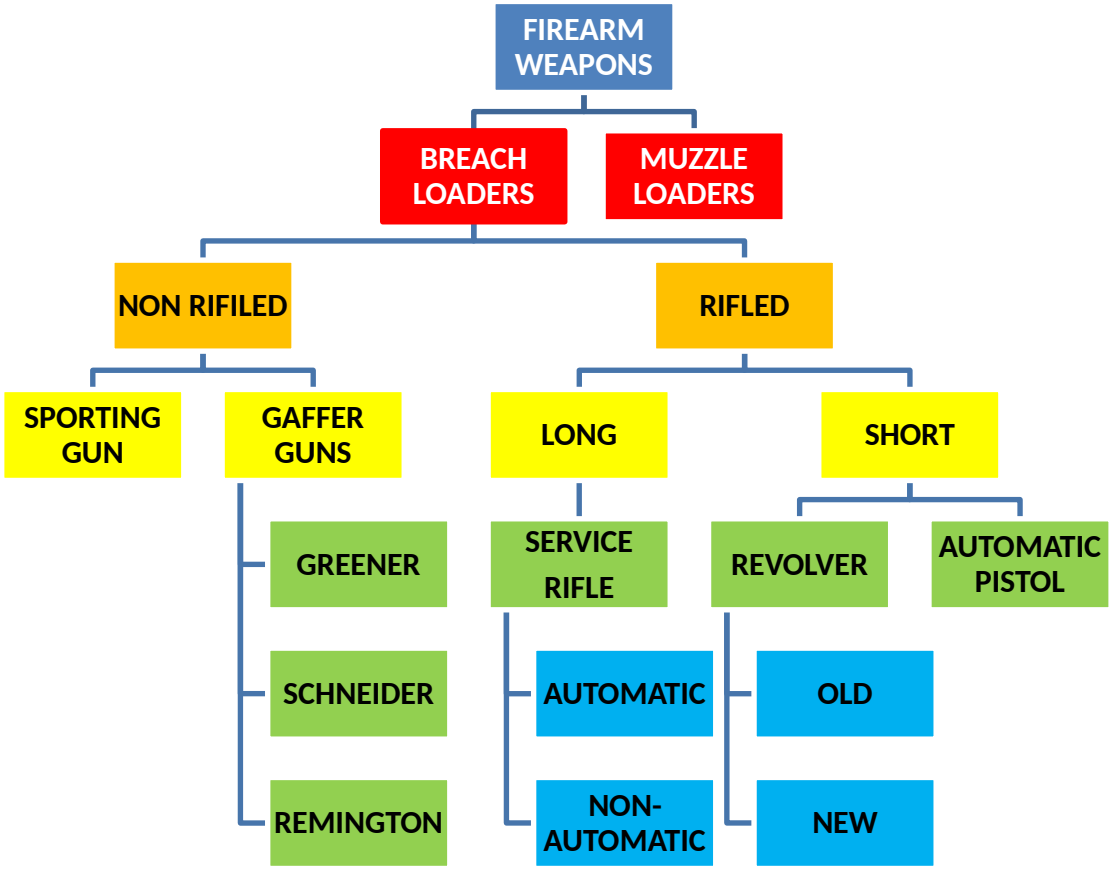
Maadi armed forces hospital

Gun shot wounds

War wounds now occur in all parts of the world other than in Wartime

So,we must understand how bullets create wounds and know the principles of treatment.

Classification of different types of weapons



Different types of bullets

Bullets after firing

Long Rifled weapon

- J F K KILLING

Automatic pistol:

Destructive effects of bullets

Bullet damage depend on: → The bullet motion in the flight
→ The bullet motion in the tissues

- ***The factors affecting this motion in the flight*** : → size
- → shape(regular or irregular)
- → composition
- → velocity(more or less than 340m/s)
- → stability

- ***The factors affecting in the tissues*** → elasticity (bone vs . Skin)
- → density (Liver vs. Lung)

Continue

- ***In general:***
- **The damage is** ⟶ *Directly* proportional to the density of tissues. ***Homogenous tissue (ms, liver, spleen,……etc) are very sensitive.***
- Light tissue(as lung) are resistance.

The damage is ⟶ *Inversely* proportional to the amount of elastic fibers present in the tissue ***(skin and lung are resistant whereas bone is very sensitive).***

Continue

A wound results from the absorption of kinetic energy

The formula is ： *KE = MV2/2* *(mass × velocity)*

The energy liberated to cause damage to a tissue:

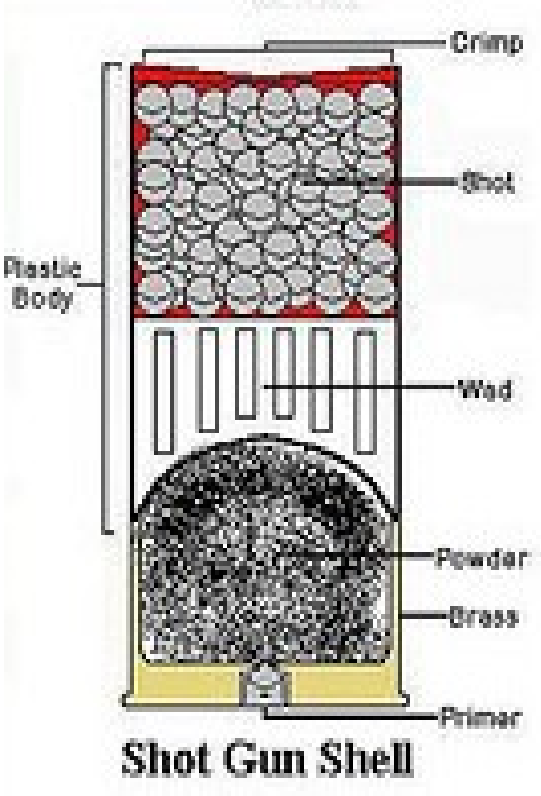
Energy expended = M (v1 – v2) /2

v1 =strike velocity v2 remaining velocity

The lower the v2,the greater the proportion of the KE that has been Liberated to the tissues. So, the retained bullets means all KE has been absorbed by the tissue.

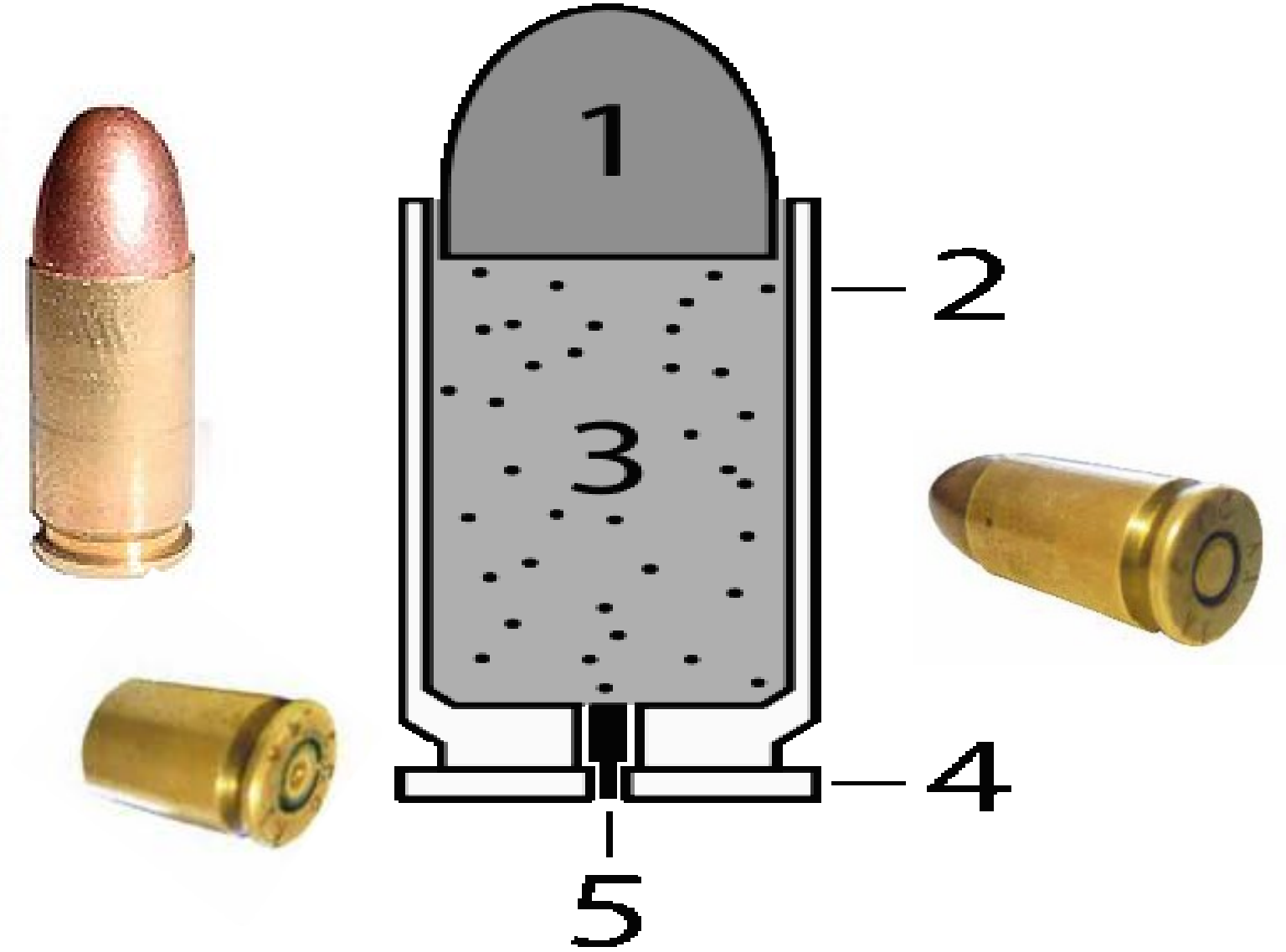
Composition of bullet

- ***Long, non-rifled weapon.***
- Cartridge of cardboard or plastic, with a brass base.
- Percussion cap:
- mercury fulminate,
- potassium chlorate,
- powdered glass.
- Black or smokeless powder.
- Internal wad.
- Shots.
- External wad.



Shot Gun Shell

Composition of bullet(pistol }



Types of shots

- Shots of sporting gun Shots of greener


SCIENCEphotoLIBRARY

Types of powders

- Black powder

- Smokeless powder

Rifles: A system of grooving the musket barrel , allowed the lead ball to fit more tightly into the barrel so that the pro-pollen gases from the explosive powder were contained behind the ball and it was ***projected faster , farther and more accurately.***

Discharge of firing

In shotguns:

1. ***Gases*** tear, redness , eversion of inlet (0-15 cm).
   hot gases & flame burning & singing of hair at inlet.

2. ***Powder:***
   burned particles blackening around inlet.
   unburned particles Tattooing around inlet.

Discharge of firing

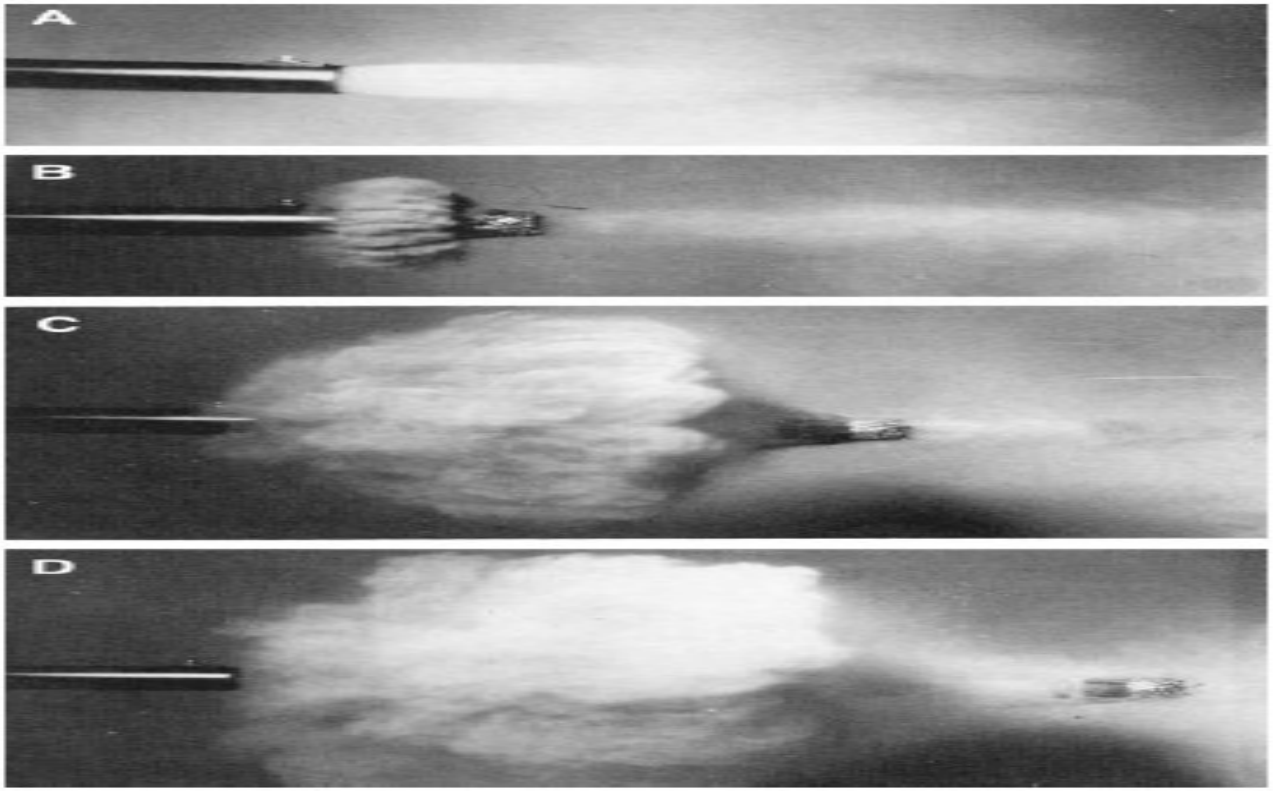


Figure 8.16 (A–D) Discharge of shotgun.

Mechanism of injury

A bullet cause injury in 3 ways depending upon its velocity:

1-Laceration and crushing 2-Shock waves 3- temporary cavitation

1-Laceration and crushing

As the missile penetrates the tissues they are crushed and forced apart.

This is the principal effect of low velocity missiles travelling at up to 340 m/s

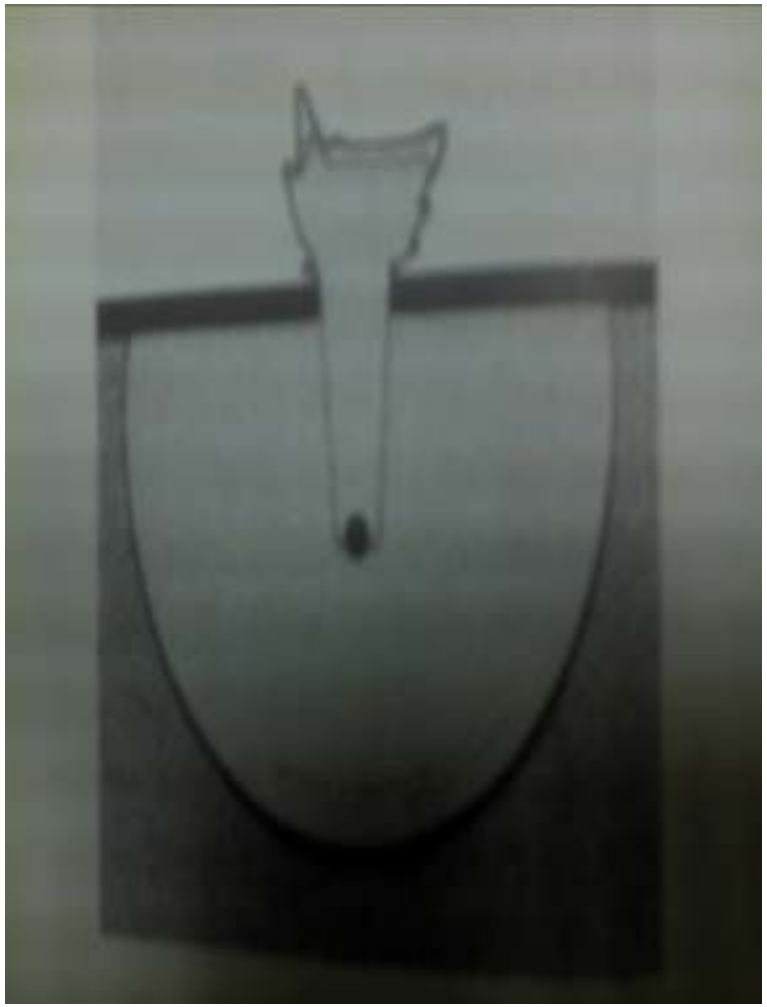
No significant energy is transmitted to the tissues surrounding the wound track.

High velocity missiles travelling at more than 340 m/s

Continue (Mechanism of injury)

- 2-Shock waves
- The missile compresses the medium in front of it and this region of compression moves away as a shock wave of *spherical form*.
- This was first demonstrated by Mach and Boys in 1893 using *spark shadow photography.*
- **The velocity of the shock wave is approximately that of the velocity of sound in water *(1500 m/s)*** and although the changes of pressure due to shock waves only last about a millionth of a second they may reach peak values of up to 100 atm/in^2 or (10^6kg/m^2).
- **Thus they can cause damage at a considerable distance from the permanent wound track(Remote injury).**

Shock waves (*spherical waves*) in water with tail splash on the surface at velocity 460 m/s



Mechanism of injury

3-Temporary cavitation

This phenomenon is encountered only with high velocity missiles.

As the penetrating missile releases its energy rapidly, it is absorbed by the local tissues which are accelerated violently forwards and outwards.

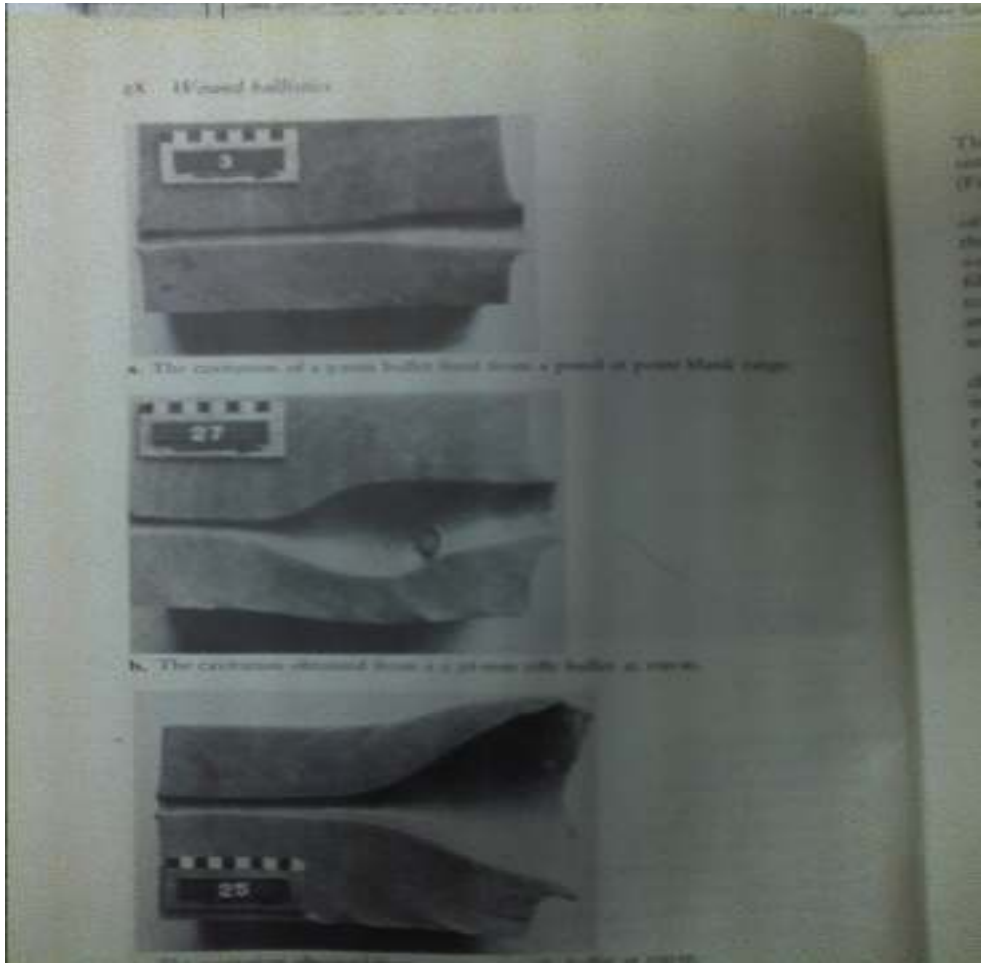
Thus a large cavity is created *approximately 30-40 times* the diameter of the missile. This cavity has *a sub-atmospheric* pressure and is connected to the outside by entry and exit holes. Therefore, bacteria ,clothing and debris are actively sucked into the depth of the wound.

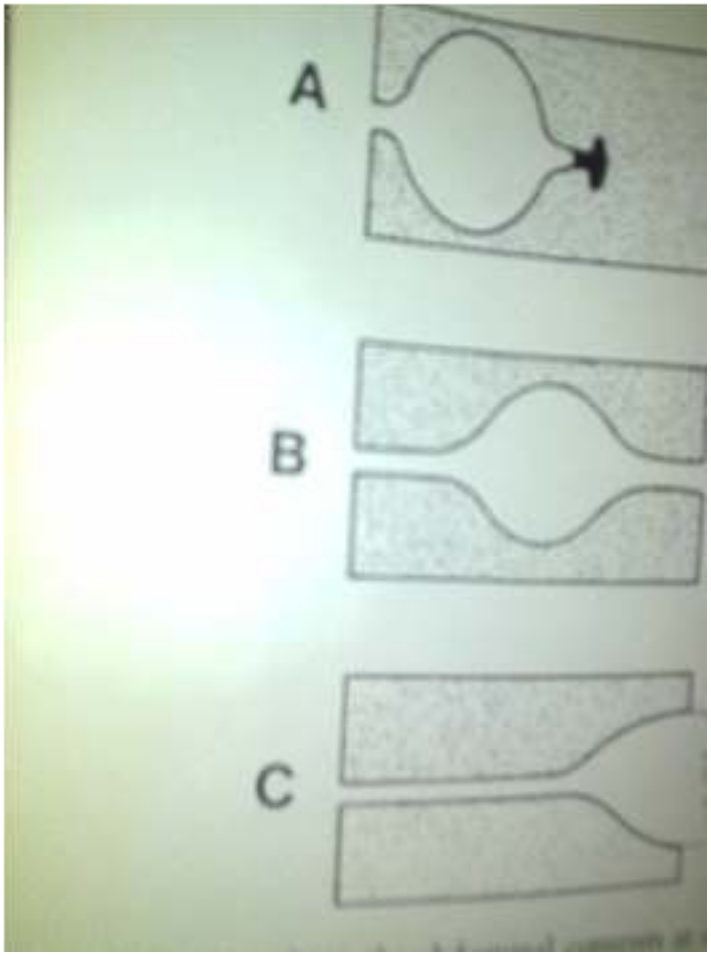
Effects of temporary cavity:

Soft tissue will be pulped, small blood vessels will be disrupted and bone may be shattered without being hit directly.

Temporary cavitation at different firing distance by different weapons in gelatin block

A . a 9mm bullet from a pistol at point blank range.
B . a 5.56mm rifle bullet at 100 m.
C. a 7.62mm rifle bullet at 100 m.



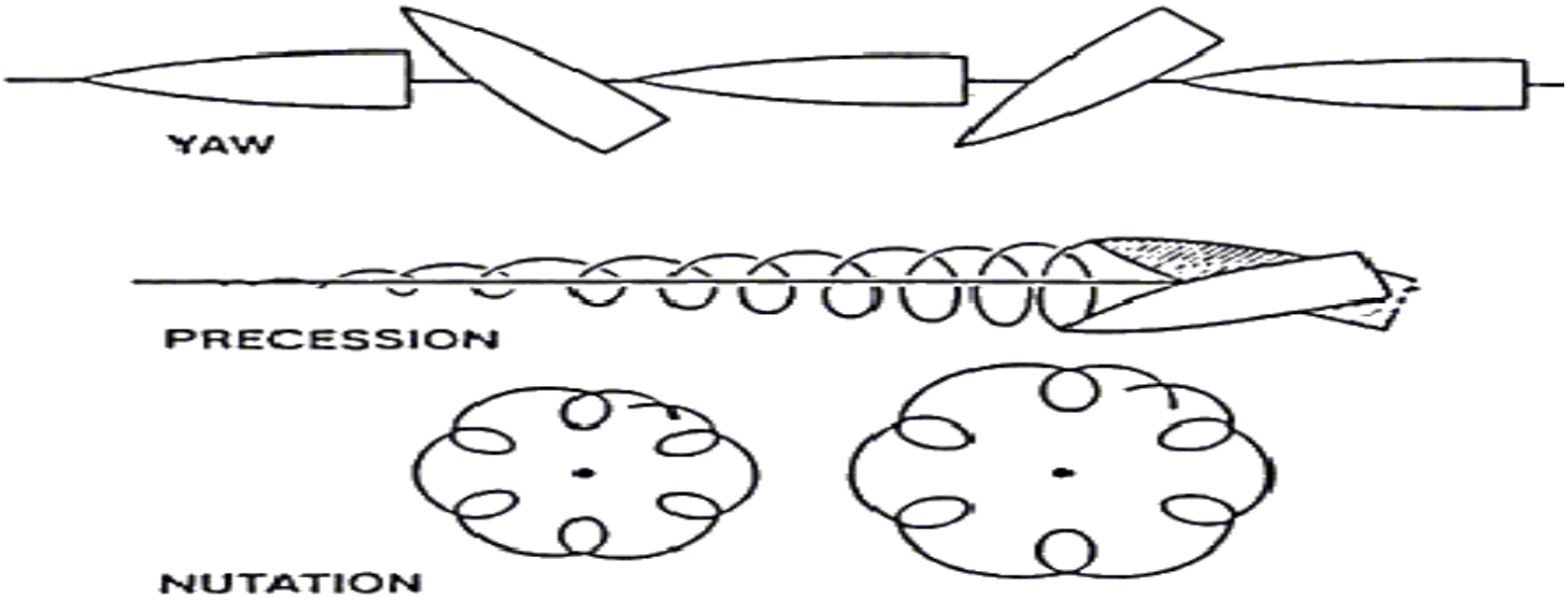


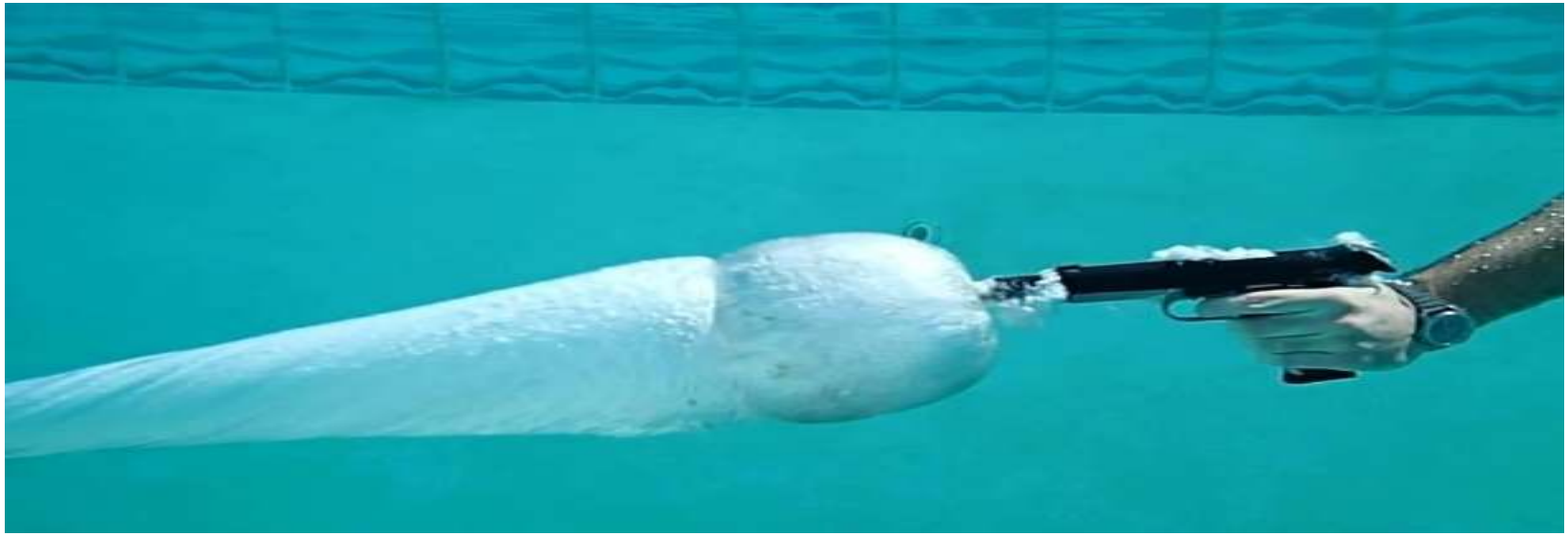
Types of bullet movements in air

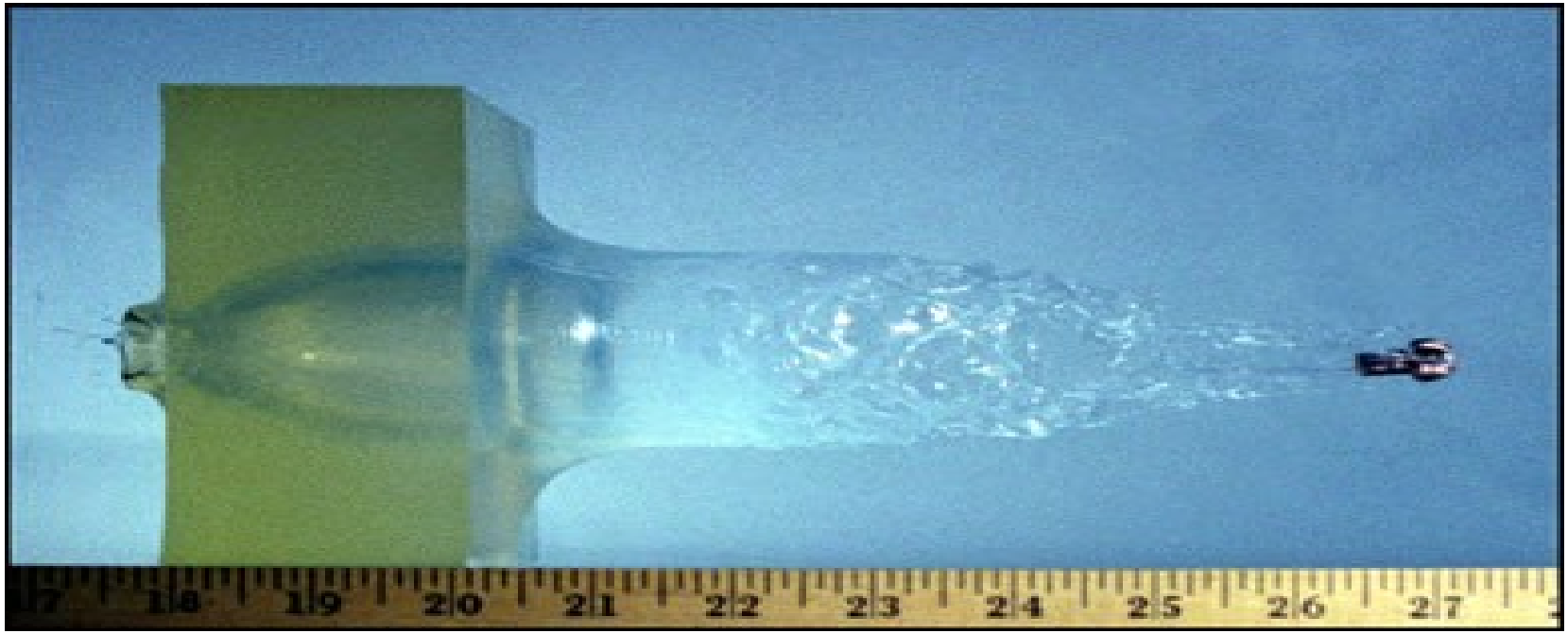
Yaw is the oscillation around the long axis of the bullet.

Precession is a circular yaw about the centre of gravity which **takes the shape of a decreasing spiral**

Nutation is a rotational movement in a small circle which forms **a rosette pattern**



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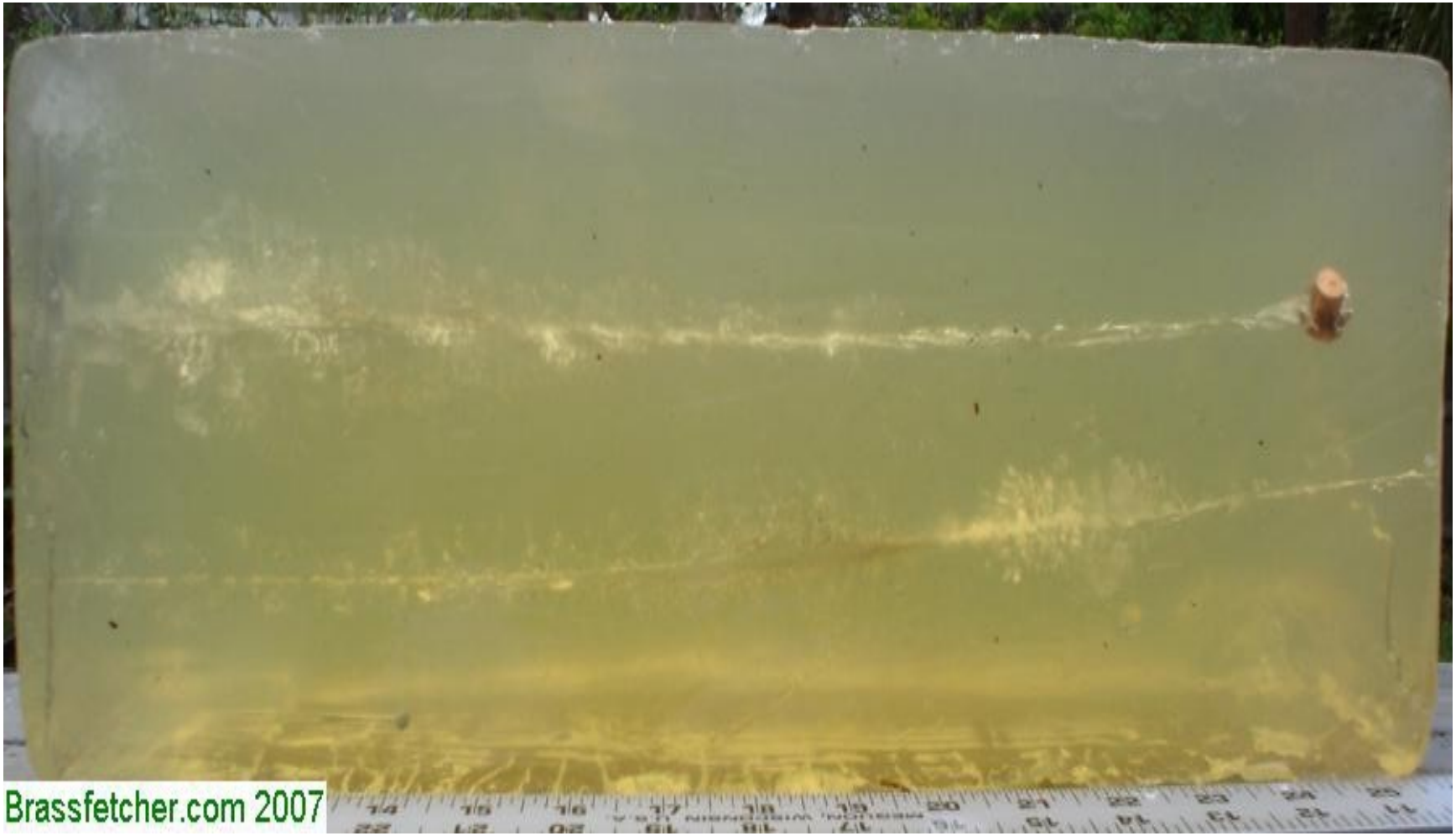
Track in gelatin block



Continue {mechanism of injury}

Pistol bullets have a relatively low amount of energy available to cause damage.

All rifle bullets have an incredible amount of available energy and great wounding power.

If a rifle bullet is stable on impact, it might go right through the limb giving up only 10 - 20 per cent of its energy. Unstable bullet may give up 60 - 70 per cent of its energy with consequently much more severe wound.

If the bullet fragments on impact, all the energy will be used up in creating horrendous wounds.

Soft bullet will flatten on impact, producing a much greater surface area and, therefore, greater retardation

Continue

- *Temporary cavity may leads to*:
- Blood vessels → disrupted
- Nerves → gross displacement → stretching → N. damage
- Bone → shattered without being hit directly
- Abdomen → large temporary cavity → displacement and damage of the viscera. The contained gas within certain viscera → compressed and then violently expanded→.The walls of the viscus may be ruptured from within, if the bullet does not actually penetrate it.
- **Thorax behaves differently from abdomen**, for it is largely filled with air(not mainly liquid – like) therefore, the conditions for formation of temporary cavity are not met . The heart and big vessels, being filled with fluid, are extremely susceptible to damage from cavitation.

Minimal tissue destruction

Reaction to bullet injury

Signs of infection(red,hot,tender and swollen)

Massive tissue destruction
(*Tissue loss,Bone Fr.)*

The principles which have been learned from war surgery that must be applied to missile wounds are:

Essential first aid

Energetic resuscitation

Wound excision

Delayed primary closure

Early repair of arteries

Historical Background of battlefield injuries

John Hunter (surgeon)

- **John Hunter FRS (*13 February 1728 – 16 October 1793*) was a Scottish surgeon, one of the most distinguished scientists and surgeons of his day**
- . He was an early advocate of careful observation and scientific method in medicine. He was a teacher of, and collaborator with, Edward Jenner, pioneer of the smallpox vaccine. He is alleged to have paid for the stolen body of Charles Byrne, and proceeded to study and exhibit it against the deceased's explicit wishes. His wife, Anne Hunter (*née* Home), was a poet, some of whose poems were set to music by Joseph Haydn.

- He learned anatomy by assisting his elder brother William with dissections in William's anatomy school in Central London, starting in 1748, and quickly became an expert in anatomy. He spent some years as an Army surgeon, worked with the dentist James Spence conducting tooth transplants, and in 1764 set up his own anatomy school in London. He built up a collection of living animals whose skeletons and other organs he prepared as anatomical specimens, eventually amassing nearly 14,000 preparations demonstrating the anatomy of humans and other vertebrates, including 3,000+ animals.

- Hunter became a Fellow of the Royal Society in 1767. He was elected to the American Philosophical Society in 1787.[1] The Hunterian Society of London was named in his honour, and the Hunterian Museum at the Royal College of Surgeons preserves his name and his collection of anatomical specimens. It still contains the illegally procured body of Charles Byrne, despite ongoing protests.

John Hunter – A very modern military surgeon

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"He who wishes to be a surgeon, must first go to war"

Hippocrates

Introduction

The history of warfare and surgery is long and complex. As Hippocrates' dictum states, war has been the crucible in which many medical advances have been pioneered, and has also been a bloody business.

In the time of John Hunter, 40% of those injured on the battlefield could expect to die of their wounds.

By the 20th century, with improved technique, anaesthesia and aseptic technique, this had been reduced to 25%, where it remained at the end of the first Gulf War (1990-1991). However, renewed interest fuelled by the conflicts in Iraq and Afghanistan, has brought about a quantum leap in the treatment of battlefield wounds, with mortality now standing at 10% [1].

This revolution has been brought about, in part, due to an improved scientific understanding of the pathophysiology of trauma .

Hunter on Gunshot Wounds

- Hunter's more conservative approach was based on the observation of a group of four French soldiers, who following injury on the first day of fighting **had hidden themselves in a Farmhouse**, and had received no medical attention. However, despite minimal treatment***, Hunter noted that they had satisfactory outcomes.***

- Hunter's practice was to allow the wound to suppurate and heal by primary intention

- .
- It is now known that to operate without aseptic technique was to introduce further contamination into the wound and, to open tissue planes to further infection.

- Modern treatment of gunshot wounds derives from surgical experience in the Great War, with surgical doctrine being centered on early surgical exploration of the wound and delayed primary closure.

- At first glance, Hunter's non-surgical approach may appear to be at odds with modern teaching. The effect of efficient rifling has been to develop highly accurate, high velocity rifles which cause significant internal damage due to cavitation, despite a benign looking entrance or exit wound [10].

- ***The Argentinian approach during the Falklands conflict of 1982 was to carry out primary wound closure without débridement, resulting in the perfect environment for anaerobic sepsis [11], highlighting the importance of Hunter's approach of ridding the wound of its slough***
-
- **Furthermore, on the modern battlefield, fragments from bombs, shells, and mortars are the principle causes of wounding , and such fragments may cause low velocity soft-tissue wounds. There is increasing evidence that a non-operative "Hunterian" approach to such wounds may be indicated**

-
- ***It is now recognised that trauma patients develop a triad of hypothermia, acidosis and coagulopathy – the so called "deadly triad***" or "coagulopathy of trauma"
-]. Whereas, traditional resuscitation methods would concentrate on the correction of acidosis and hypothermia, and surgery on the control of haemorrhage and contamination, the modern doctrine of "Damage Control Surgery" is a concept where initial surgery is directed at the restoration of normal physiology. Following this initial and limited surgical intervention, there is a period of stabilisation in an intensive care facility, before returning to theatre for definitive treatment.

- **The concept is likened to the naval doctrine of damage control: any initial efforts must be to keep the ship afloat, not to restore the ship to its original state.**
- Importantly, damage control surgery "recognizes that outcomes after major trauma are determined by the physiological limits of the patient, rather than by efforts of anatomical restoration by the surgeon .

Principles of treatment of mass casualties

- Triage (casualty sorting):
- ***Group A*: *slight injuries managed by self help* ⟹ *can segregated***
- ***Group B* : *This injuries requires simple treatment* ⟹ *segregated***
- ***Group C* :*This injuries requires surgical attention and operation***. These are further categorized into priorities (1 to 3)

  Priority 1 ⟹ Cases require resuscitation and urgent surgery (Asphyxia..)

  Priority 2 ⟹ early surgery and possible resus. (Vascular, visceral injury)

  Priority 3 ⟹ Less urgent surgery (Fractures, eye injury ……)

  Distinction between priority 1 and 2 is not always clear.

  Group D* : *Dead or who have severe injuries that death is inevitable.

Vascular injuries

- ***The major advance in Vascular surgery that have been applied to bullet wounds have been made since the war in korea ,which significantly reduce rate of limb amputations due to vascular repair.***
- *Types of blood vessels injuries*:
- 1 Lacerations (intimal tear, wall dissection, contusion)
- 2 Transection
- 3 Avulsion
- 4 Extra-vascular compression
- *The signs*: pale , cold, cyanosis , mottled → No pulse
- **Golden role**
- **Presence of a distal pulse dose not rule out arterial injury.**
- **Absence of a distal pulse dose not mean arterial injury.**
- ***Amputation: may save the life***

Firearm injuries received from 25th. Of Jan. 2011 for one year long

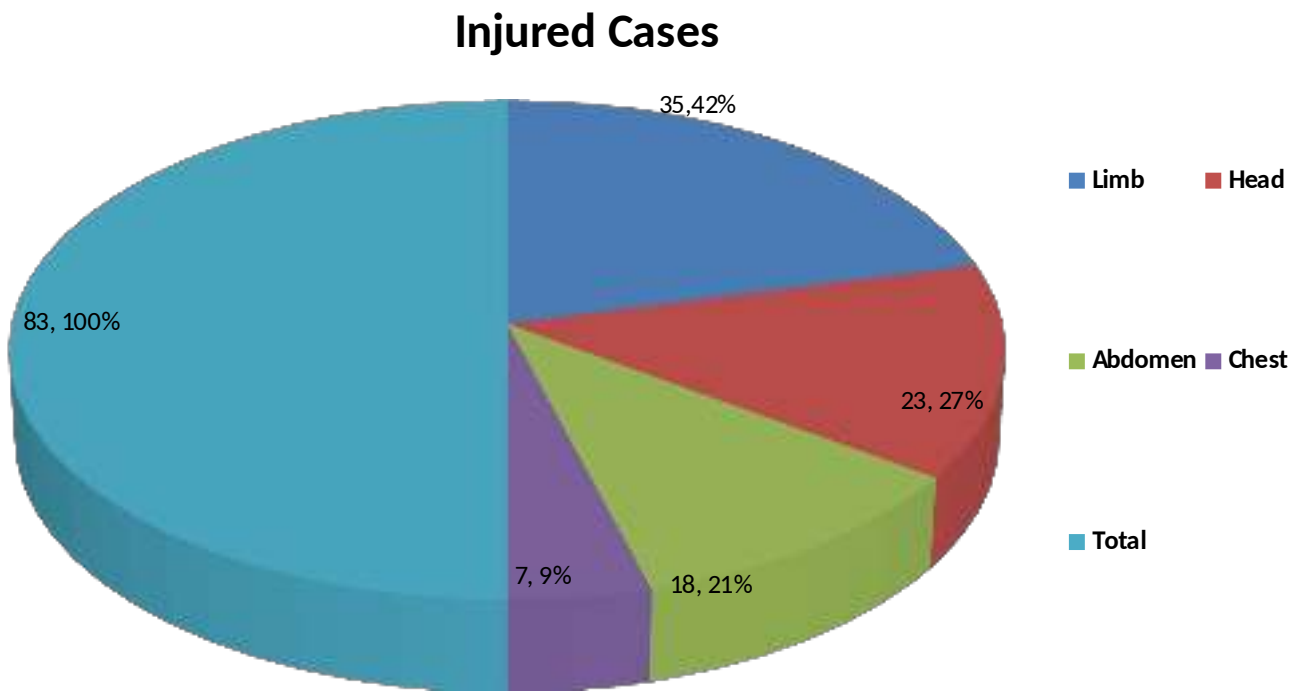
MAADI EXPERIANCE

- *Total numbers of injured cases received are* ⟹ 84 cases
- Male 82 Female 2
- *The sites of injury*:
- Limbs 38

- Head and neck 24
- Abdomen 21
- Chest 11

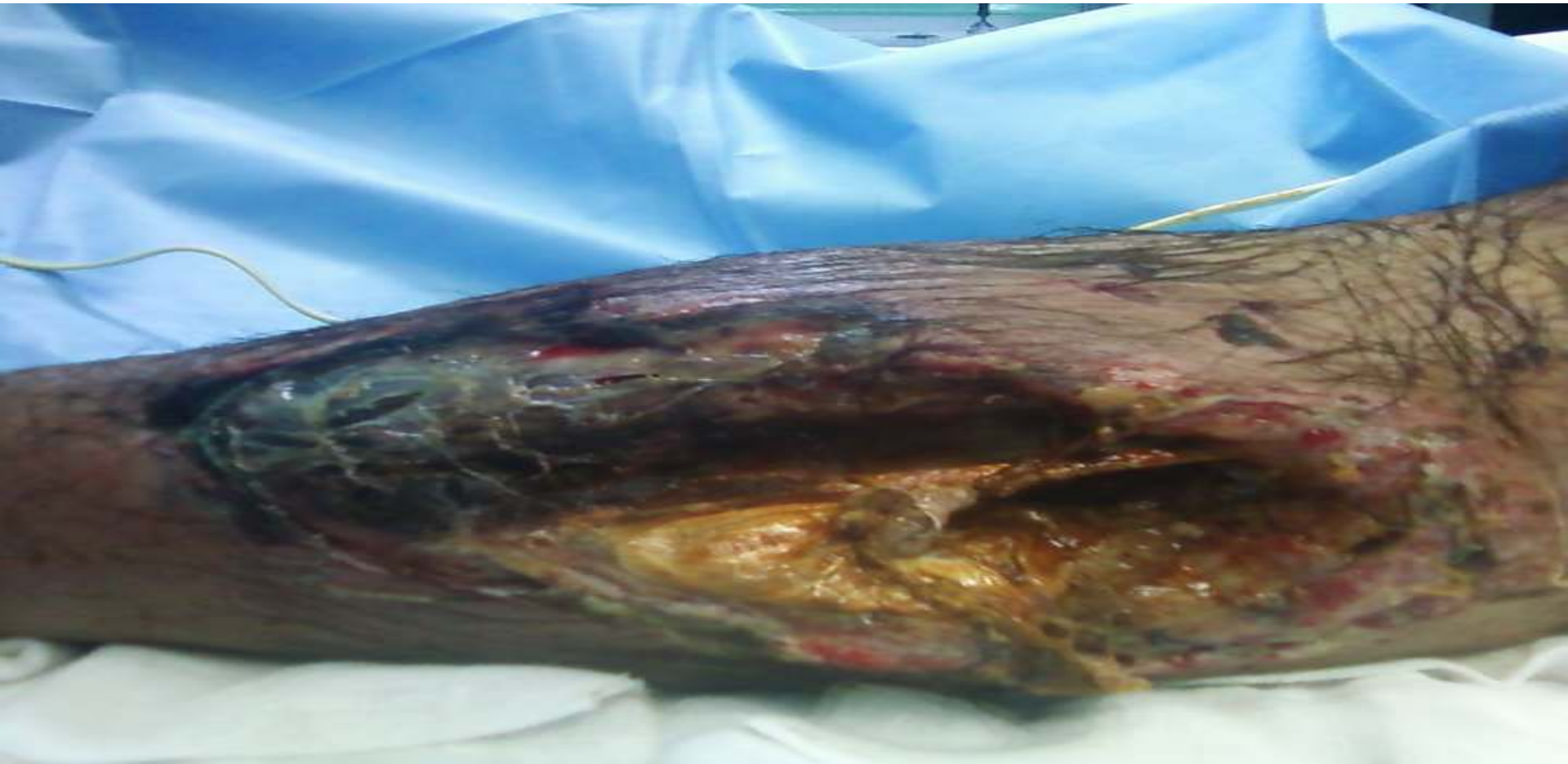
- Conservative treatment 6 cases (antibiotics, daily dressing……..etc)
- Surgical intervention 78 cases (debridement, fixation, vasc. Reconst…..etc)

Percentage of Injured Cases From 25th Jan. 2011 for one year long



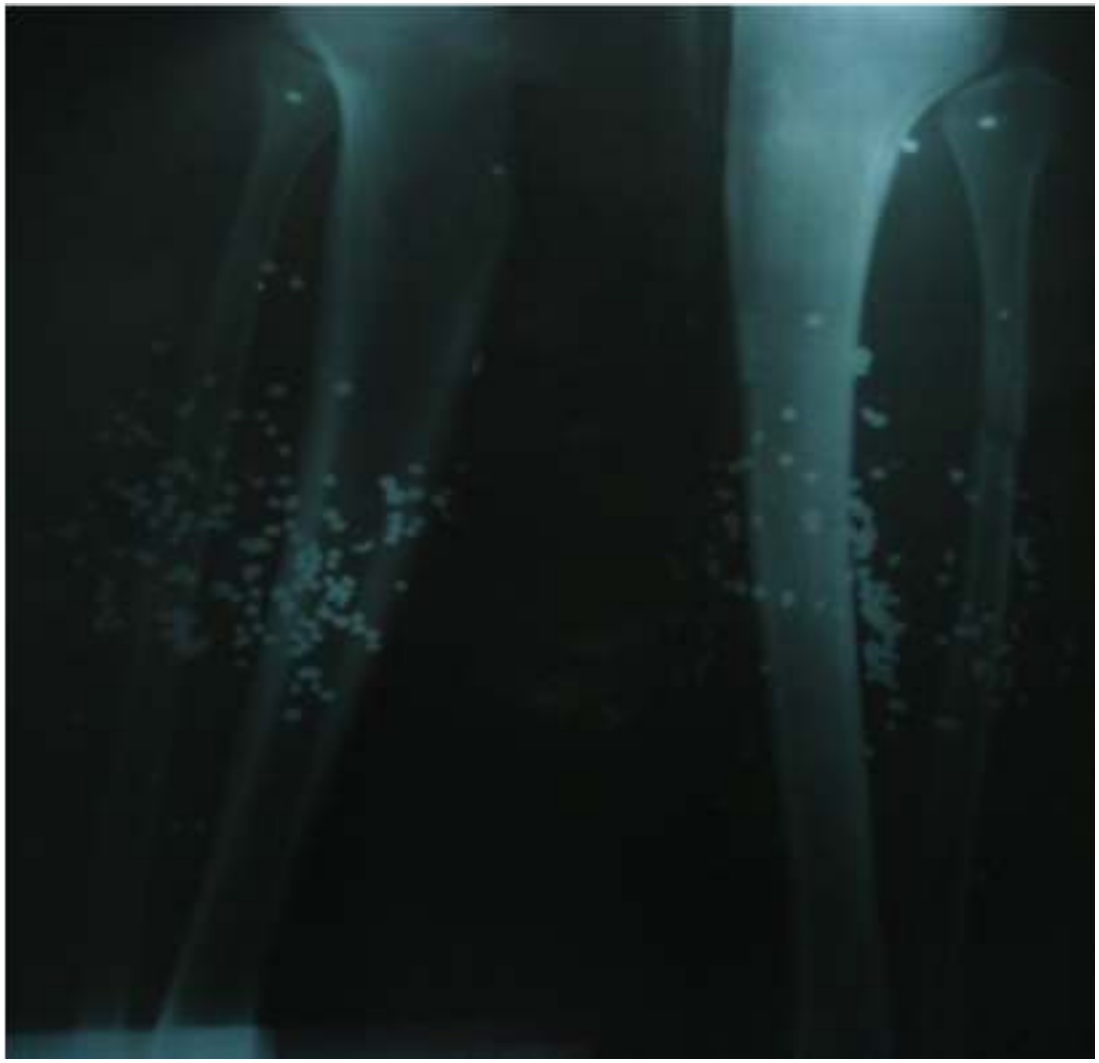
Case : 1

A male patient,38 years old. He had gunshots injury to his left leg. First aid and debridement with primary closure of the wounds were done in a private hospital. A 10 days later, The patient was transferred to our center. This is picture on arrival



The plain x ray finding

- Many shots retained
- Fr. fibula



Dead ms.

Debridement

Ended by B K Amputation

Case : 2

Male patient,40 yrs old. Bullet injury (Inlet in the medial aspect of the thigh, Exit in the lateral aspect of the leg).good pedal pulse

Normal C T Angio

3 weeks later

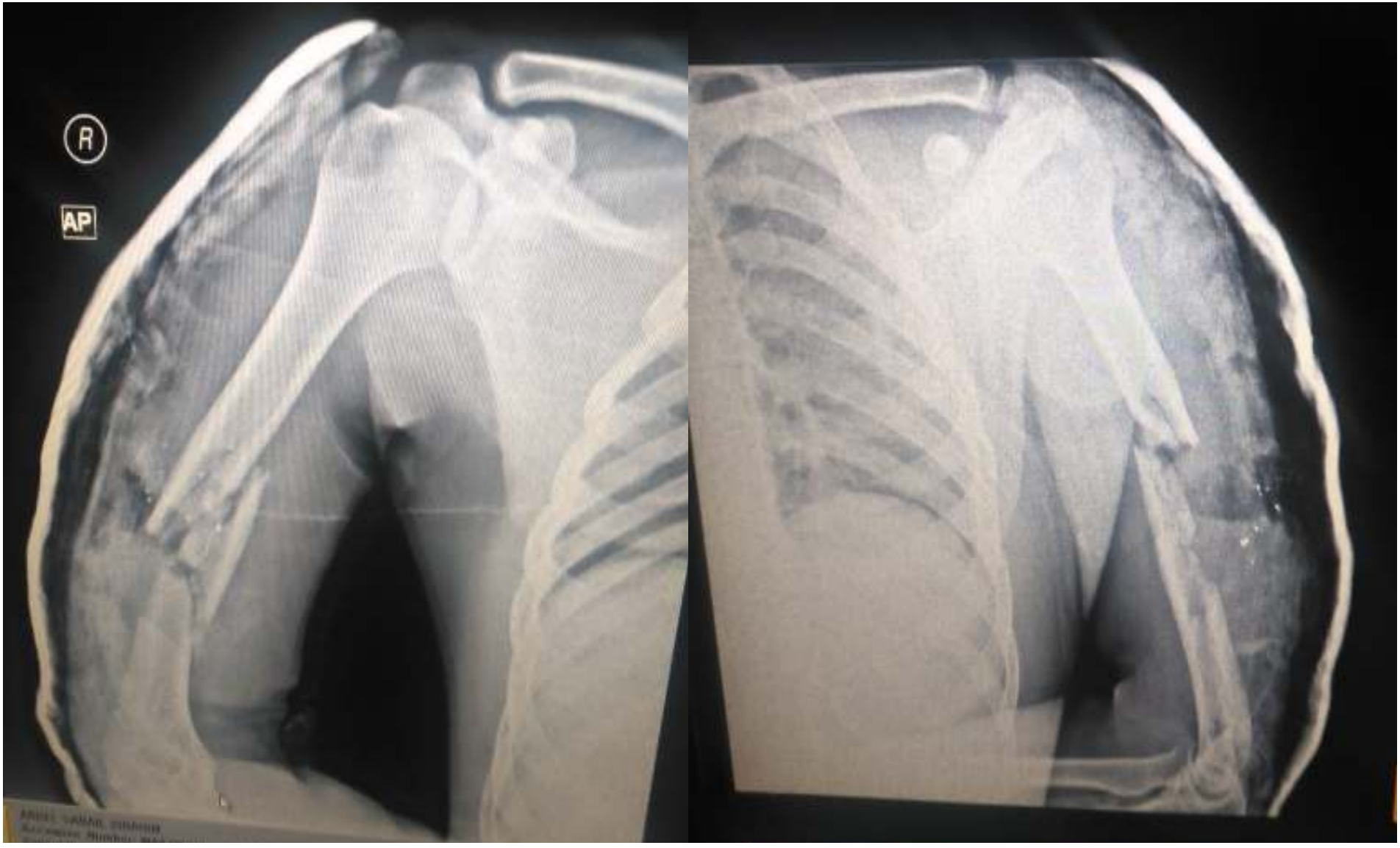
Case : 3

Male patient,42 yrs old. Bullet injury in the left arm (No distal pulse) Exploration was done

Reconstruction of the Axillary A. and V. and median nerve

Case : 4 This is the case on arrival
How could you manage this case.

Case : 5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AP

Case : 6


AHMED, HAMEL

Case : 7

Case : 8

conclusion

- *Today ,any surgeon in any hospital in any city in the world may suddenly be called upon to treat a patient with gunshot*

- **Those who do not remember the mistakes of the past are condemned to repeat them (*The Philosopher Santanya*)**

THANK YOU