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1. Learning Outcomes

After studying this module, you shall be able

- To understand the concept of Gun Shot Residue, broadly
- To know about it's various components and different methods of collection.
- To understand its importance in providing leads in investigative trials

2. Introduction – Gun Shot Residue

Mechanism for Formation of Gun Shot Residue

Gunshot residue (GSR) also referred to as Cartridge-case Discharge Residue – CDR, or Firearm Discharge Residue – FDR). These are unburnt or partially burnt particles, gases, non-volatile substances coming from primer, propellant, bullet and firearm. These are visible and invisible depending on various factors. Their location, testing and identification plays a very important part in the investigative trials, while absence of GSR, can also give significant information.

Fig 1: Showing Gun Shot Residue

3. Areas of GSR Deposition

GSR may be looked for

- On the hands - mainly present on thumb, trigger finger and web of hand
- On the clothes of the victim, if the human being is the target
- Intermediate targets may also have GSR depositions
- Inside of cartridge cases and barrel may have GSR. In addition outside surface of barrel can also be examined for GSR.
- Fired projectiles may also be examined for gunshot residue.

The presence of GSR at the expected region of hands, arms, face and clothes of the suspect also helps to ascertain whether he or she had actually fired the projectile or not. The firing of a weapon not only propels residue towards the target, but also blows gun powder and primer residue towards the shooter. Deposits of GSR are found on the "web" region of the hand, as indicated in the figure below:

Fig 2 (a) and 2 (b) showing areas of GSR deposition

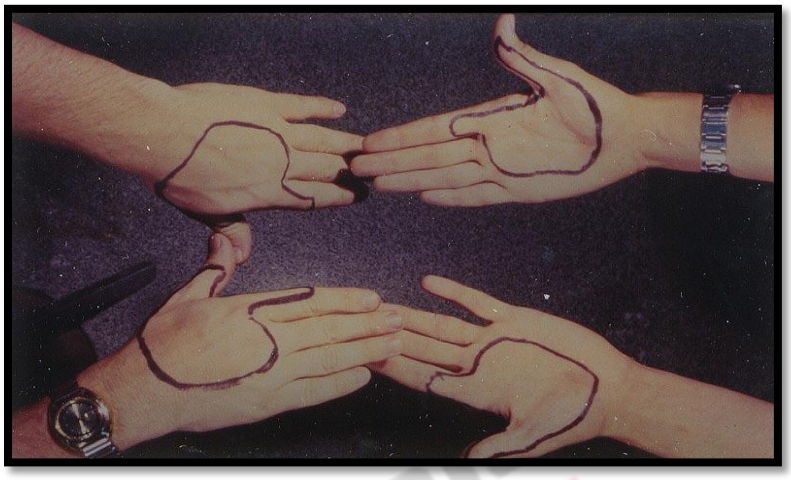

Fig 3: showing maximum area of GSR deposition

4. Production of GSR - Distant Range and Contact Range

4.1 Production of GSR and Distant Range

- In the case of distant-range firing there will be no GSR like blackening, scorching and tattooing as well as metallic chips around the hole of entrance. All of them will not appear and remain absent.

- However, during the passage of a bullet through the rifled barrel and through a defective, roughened or country made weapons (also termed improvised weapons), small fragments of metal are cut and propelled in the direction in which projectiles are ejected.

- In view of the fact that these particles are heavier than the powder grains they travel longer distance beyond the maximum distance to which powder grains are ejected.

- Similarly some grey color or tiny metallic particles which had been cut during their travelling through roughened bores or rifled weapons may appear on the edges of entry holes which would be circular in case of normal shot and oval in case of angular shot.

- The trace element analysis will reveal the true position. It may be noted that a contusion ring be partially or completely obscured by a ring of dirt is formed. Lubricants, dirt, dust and metal shavings lead to the formation of ring of dust.

4.2 Production of GSR and Close Range

- While a weapon is fired, and the muzzle end is expected to touch the target it is termed contact range.
- When the contact is tight and pressing the surface of a target uniformly and close, the skin surrounding the perforation is not tattooed or blackened with embedded powder grains as in a case of close-range shot indicating absence of GSR, but this may not happen, always.
- Occasionally, some burned and unburned powder grains may get deposited on the skin in and around the margins of entrance wound.
- It is just possible that the weapon may be lifted, on one side due to manufacturing defect in country made weapon or due to careless handling by the shooter or efforts made by victim. To escape an attack, resulting in losing of light contact giving rise to escape or burned and unburned powder grain and their deposition on the skin.
- In a tight and proper contact, all the GSR as well as ammunition would be driven into track made by the ammunition through the entrance hole.
- The imprint of the muzzle end may be evident around the entrance wound in case of pressed shots, but no appearance of GSR.
- The tissue around the bullet track will appear as a bright red Colour due to its reaction with carbon monoxide, which is a product of combustion (GSR).

- Contact shot over the forehead or that region of the body where the bone is thick would be marked by appearance of a large irregular and stellate or elliptical shape formation of GSR, produced by the force of expanding gases between the skin and the tissues.
- From the aforesaid discussion about the GSR produced during firing are available as follows -

(a)In close range firing, dust ring, burning, blackening and tattooing appears as GSR on the target as shown in the figure below. The burning of skin is accompanied in by the track shown in the figure due to its reaction with carbon monoxide which is also a product of combustion (GSR).

(b) In distant range firing, no powder pattern is available but tiny metallic particles, which have been cut during travelling through the barrel, appear on the edges of entry wound on the target.

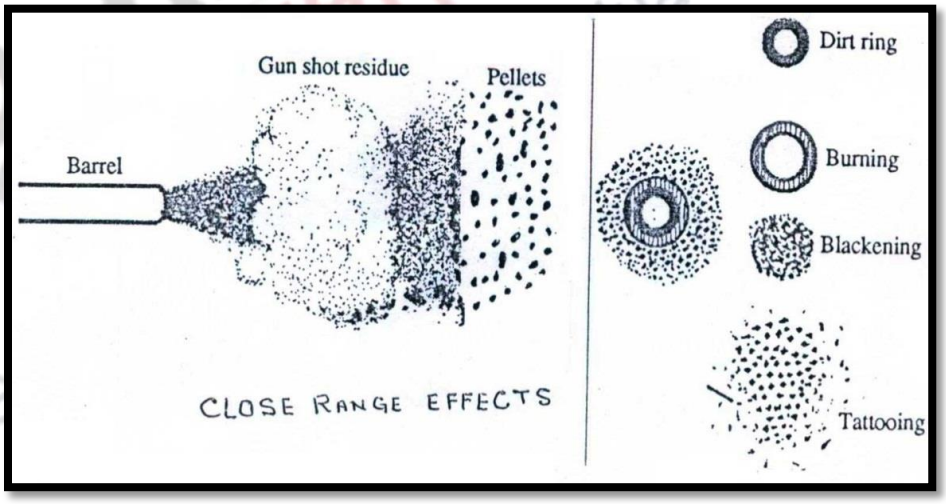

Fig 4: Close range effects of GSR

(c) The ring of dust, caused as a result of firing, consists of lubricants, dirt, dust and metallic particles appears on the target with GSR

(d) Occasionally GSR may be found on entry found of contact firing when contact is not tight giving vent to gases.

(e) In case of contact firing, it is the entry which has projectiles and other GSR in the track of the hole in additions to the above mentioned locations GSR can be located at the following places or articles:

- Articles around the target or around the shooter or both, depending upon the nature of firing, may contain GSR.
- Clothes and other garments of the victim, which act like intermediate targets, may have GSR on them.

(f) The GSR particles are dispersed in the air. Being light particles, they continue in the air for a long time. They may be transferred to a surface, which comes in contact with air, or surface, which already has GSR.

(g) Intermediate targets, other than clothes, may also have GSR when a projectile hits a glass windowpane or a wooden door. The holes created by a bullet in a glass pane or wooden door would carry especially the GSR, load particles, and many others depending on the cartridge cases and primer.

5. Gun Shot Residue – Classification and Composition

Composition, classification, production and nature of gunshots residues is very complex and their composition depends on several factors like composition of propellants & primers, composition of projection, composition of barrel and barrel fouling.

5.1 Composition of Propellants and Primers

5.1.1 Black Powder

Black powder is the oldest recorded propellant invented by Chinese around the tenth century. It has the following composition

- Potassium nitrate (salt peter) - 75%
- Finely divided particles of charcoal - 15%
- Sulphur - 10%

- Saltpeter furnishes the oxygen while the Charcoal and Sulphur are the fuels. Black powder produces lots of smoke that could easily reveal the position of the shooter.

5.1.2 Smokeless Powder

Smokeless powder was developed in the late nineteenth century to replace black powder as a propellant in weapons as smokeless powder are for more energetic propellant per unit weight.

There are two varieties –

- Single base
- Double base

The basic components of the smokeless powder are Nitroglycerine and Nitrocellulose (gun cotton). Nitrocellulose is used alone or in combination with Nitroglycerine, to form smokeless powders. The former is called single base powder and the later double base powder. Cordite and modified cordite are double base powders. Some smokeless powder is an intimate mixture of Nitrocellulose, Potassium Nitrate, Charcoal and sulfur in the approximate ratio of 20: 60: 12: 8.

5.2 Primer

In the modern primer, mercury fulminate has been replaced .The type of primer being used now in India has the follow composition:

(a)	Lead styphnate	32 – 42%
(b)	Antimony sulphide	13 – 17%
(c)	Barium nitrate	27 – 37%
(d)	PETN	4 – 6%
(e)	Tetracene	3 – 5%
(f)	Aluminium	6 – 8%

5.3 Inorganic Components of Smokeless Powder

The inorganic materials in modern smokeless powders and primers giving rise to GSR can originate from several substances, which are given below:

(a) From primers
- Lead, Barium antimony

(b) From propellants
- Nitrites, Nitrates and carbon monoxide - a gas produced by propellant and gets absorbed by skin and flesh, turning them to bright red color or cherry red Colour.

(c) From Jackets
- Copper, Zinc and Nickel also in cases where shells are coated with Nickel.

(d) From barrels
- Iron from barrels

(e) From bullet
- Lead

(f) From carbon in propellants
- Particles of carbon

All these GSR are produced from propellants primers bullets and jackets and are inorganic in nature.

5.4 Organic Components of GSR

(i) Nitrocellulose, the unburnt or the semi-burnt part of the main component of the propellant.

(ii) Lubricants used for lubricating bullets are organic in nature and appear as GSR.

(iii) When double base propellants are used, the unburnt and semi-burnt parts of Nitroglycerine.

(iv) Organic materials used as plasticizers are also detected as GSR.

6. Collection of Gun Shot Residue

The GSR can be collected by several methods some of them are briefly described below:

6.1 Dry Methods of Collection of GSR

(i) A cellophane sheet is impregnated with acetic acid, after impregnation the same is pressed against the site. It will pick up bad particles.

(ii) Use of adhesive tapes

An inert adhesive tape (or an adhesive aluminum tape) is pressed against the site bearing the GSR many a times to pick up the desired GSR which can then be subsequently selected for examination.

(iii) A solution of cellulose acetate is applied bearing the GSR. When it gets dried up it may be peeled off and the gunshot residues will be picked up by the cast.

(iv) The site bearing the powder marks is sprayed with a colloidal solution. The film is reinforced with nylon fibers. The reformed film that picks up the GSR is peeled off on drying.

(v) The residues in the barrel are collected by washing the same with hot distilled water. The washings are tested for constituents of the gun powder residues

6.2 Collection of Organic Residues

The evolution of the organic component of GSR is gaining importance day by day and especially in the recent times. Some of the techniques of collection are mentioned briefly:

(a) Technique of Swabbing

A clean piece of cloth or a filter paper is moistened with an organic solvent, which may by acetone, alcohol or ether and the site suspected of containing GSR is swabbed. The swabs are collected and extracted.

(b) Tape lifting technique

An inert tape having 2-3 cms width is taken and the site is taped to pick up all GSR-of organic and inorganic origins. This technique is becoming very popular because of convenience in collection of both organic & inorganic GSR as well being economical and can be carried out quickly.

(c) Vacuum Lifting Technique

This technique is especially suitable for collecting of GSR from clothes. The material deposited on the filter dust is extracted with a suitable solvent for further processing.

Sometimes the lack of color contrast between the powder and the garment or presence of heavily encrusted deposits of blood can obscure the visual detection of gun powder. Often an infrared photograph of suspect area, on the garment, overcomes such the problem.

The figures below, gives a clear understanding of the above-discussed points

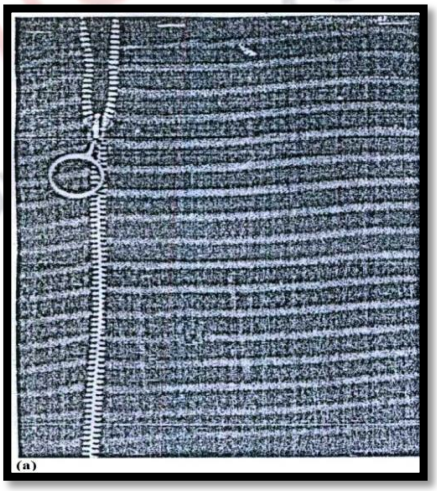

Fig 5(a): shirt bearing a powder stain, photographed under normal light

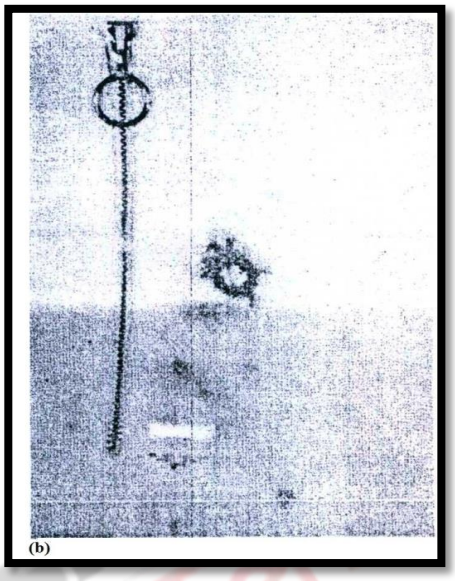

Fig 5(b): An infrared photograph of the same shirt.

7. Summary

- Gunshot residues or GSR are also known as firearm discharge residues.
- The location, testing and identification of GSR play a very important part in the investigative trials, while its absence also give significant information.
- GSR particles detection helps in the bullet holes identification and the GSR particle dispersion pattern helps in estimation of range of fire.
- Black powder is the oldest recorded propellant invented by Chinese around the tenth century.
- There are two varieties of smokeless powder–
  - Single base
  - Double base
- The basic components of the smokeless powder are Nitroglycerine and Nitrocellulose (gun cotton).
- The presence of GSR at the expected region of hands, arms & face and clothes of the suspect also helps to ascertain whether he or she had actually fired the projectile or not.
- In the case of distant-range firing there will be no GSR like blackening, scorching and tattooing as well as metallic chips around the hole of entrance. All of them will not appear and remain absent.
- The GSR can be collected by several methods like
  - Dry methods of collection of GSR - Use of adhesive tapes
  - For collection of organic residues – Swabbing, Tape lifting, Vacuum Lifting etc.