Collection of Gun Shot Residue using White Adhesive

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Abstract: *The gun shot residue is the microscopic particles formed by the compltely burnt, partially burnt priming compound and propellant particles involving metallic residue, nitrate compounds, gases etc, left after the propulsion of projectile from the firearm. It is in the form of small dust like particles which settles on shooter's hand, clothings etc. The GSR needs to be collected through various methods for further analysis such as wet methods, dry methods etc. This study involves a method to collect Gun Shot Residue using white adhesive, a type of dry method, due to its adhesive properties, this method is better than conventional parffin peeling method. This research aims on comparing properties of traditional paraffin method and white adhesive method such as drying times, durability and handling etc.*

Keywords: ***Gun Shot Residue, Primer, Propellant , adhesive, paraffin.***

1. INTRODUCTION

Gunshot Residue (GSR) refers to the microscopic particles left on a shooter's hands, clothing, or other surfaces after firing a firearm. These residues primarily consist of metals such as lead, barium, and antimony, which are commonly found in ammunition components. The detection of GSR can be used as forensic evidence in criminal investigations to determine whether an individual has recently discharged a firearm. When a weapon is fired, a great volume of incandescent gaseous material is produced, at this time its temperature is around 2000^0 C This gaseous material is mainly the combustion products from the propellant and consists of carbon dioxide, carbon monoxide, water as steam and oxides of nitrogen. In amongst this vast cloud of gases are also partially burnt and unburnt propellant particles and combustion products from the priming compound. These solid particles are collectively called *GSR*
particles. Less frequently, they are also referred to as *firearms discharge* residues.The vast majority of the GSR particles produced during the firing of a cartridge consist of partially burnt and unburnt propellant particles which are mainly organic in nature. The rest consist of the metallic compounds left over from the discharged priming compound. In addition to these, some particles of plain lead, which have volatilized from the base of the bullet, or copper and zinc particles from the inside surface of the cartridge case, are also often found amongst the GSR particles.

Formation Process of GSR: The process of GSR formation occurs during the discharge of a firearm in several stages:

a. Firing the Gun:

- When a gun is fired, the **primer** inside the cartridge is struck by the firing pin.

- This causes the **primer mixture** to ignite, which in turn ignites the **gunpowder** in the cartridge.
- The combustion of gunpowder generates high-pressure gas that propels the bullet out of the barrel.

b. Release of GSR:

- During the ignition and discharge process, the primer material (which typically contains lead, barium, and antimony) is expelled from the cartridge case, creating **GSR particles**.
- These particles are small and lightweight, often less than 10 microns in diameter, allowing them to travel through the air and land on the shooter's skin, clothing, or surrounding surfaces.

c. Dispersion and Deposition:

- The particles may be blown into the air along with other gases and debris created during firing.
- They may settle on nearby surfaces, including the hands and clothing of the shooter, as well as any surrounding objects, like door handles, walls, or victims.
- GSR particles can also be dispersed to greater distances depending on environmental conditions such as wind speed and direction.

Composition of Gunshot Residue (GSR): GSR particles typically consist of:

- **Lead (Pb):** A primary component of the primer in ammunition. Lead is toxic and a key element in GSR.
- **Barium (Ba):** A component of modern ammunition primers, often used in combination with lead.
- **Antimony (Sb):** Another element found in some primer compositions. These three metals—lead, barium, and antimony—are the primary markers for identifying GSR.
- Other trace elements and compounds might also be present depending on the ammunition used and environmental conditions. The specific formulation of the primer and propellant in ammunition may vary, but the lead-based compounds are most commonly associated with GSR.

Collection of Gun Shot Residue:

Gun Shot residue is generally found on shooter's back of hands, and webs of fingers, clothing etc. It can be collected in all types of crimes but mainly in homicidal cases, with each passing
hour, there is more and more degradation of evidence as lesser GSR particles are left for accurate analysis leading to difficulty in detection sensitivity. The collection of Gunshot Residue (GSR) is an important step in forensic investigations, as it can provide valuable evidence of a suspect's involvement in a shooting incident. Proper techniques for collection, preservation, and analysis are critical to ensure the reliability and validity of the results. Swabbing, tape lifts, and vacuum collection are common methods used, each having its advantages and challenges. Ensuring timely and contamination-free collection, along with maintaining the chain of custody, is essential for a successful forensic investigation.Depending on the residue type present at the SOC whether organic or inorganic, the collection method varies. But the basic type of collection methods is of two types: Dry method and Wet method.

Dry Method includes paraffin wax, cellulose acetate, adhesive tapes etc for lifting of GSR particles, Vacuuming etc. whereas the wet methods includes Dilute HCl, Acetic Acid washing and distilled water washings.

These methods are described as:

DRY METHODS:

Paraffin method: In this method, a paraffin coat is poured on the victim's hand and left there for a few minutes to entrap the residues. According to Locard's principle, the GSR gets deposited on the paraffin and then further analyzed for the type of residue present.

Tape lift method: A simple technique which uses tape to lift the particles or residues from the region where the crime occurred. This method usually involves adhesive tapes that can easily trap the samples. The tape lifting method is found to be widely used in lifting of physical evidence succh as fingerprints and explosivs or gunshot residue analysis.

Vacuum lift method
The sample which needs to be collected is vacuumed up and collected onto a filtered trap which is attached to the vacuum. The collected sample is then packed in a clean trace paper and then submitted to the laboratory for further analysis.

WET METHODS:

Washing: This method includes the washing of the are involving GSR using acid or sometimes water. Here, the hands of shooters or nearby areas at the scene of crime are washed with dil. HCl and then these are collected in a plastic bottle.

Swabbing: Swabbing means using some adsorbent surface for the collection of samples from the surface for collecting nitroglycerine and othe GSR particles from hands, solvents such as ethanol acts as the best solvent with more stability and recovery , sometimes saline solutions are also used for swabbing.

Handling and Preservation of GSR Evidence

- **Proper Packaging:** After GSR is collected using swabs or tape, the samples should be sealed in airtight, clean containers to avoid contamination or loss of particles. For swab samples, this could be a test tube or a sealed bag. For tape lifts, the adhesive tape should be placed in a clean envelope or bag.
- **Labeling and Documentation:** Each sample must be properly labeled with relevant information such as the time and location of collection, the identity of the person from whom the sample was taken, and any other pertinent details. This ensures a clear chain of custody.
- **Chain of Custody:** Maintaining an unbroken chain of custody is critical in preserving the integrity of GSR evidence. Each transfer of the sample from one person to another must be documented, and the sample must be stored securely.

Factors Affecting GSR Collection

- **Time Between Firing and Collection:** The sooner the GSR can be collected after a firearm is discharged, the higher the likelihood of detecting particles. GSR can dissipate over time due to natural activities, washing, or environmental exposure.

- **Personal Hygiene and Environmental Factors:** GSR particles may be removed by washing hands, handling objects, or environmental factors such as wind or rain. These factors must be considered when interpreting the results of GSR testing.
- **Cross-Contamination:** If a person is exposed to GSR from sources other than firing a weapon, such as from being near someone who has discharged a firearm, this can lead to potential contamination of the sample. Therefore, care must be taken during sample collection to avoid accidental contamination.

The method experimented in this study was usage of white adhesive which is readily available at all places, here we are going to compare this method with all other methods and proceed with the results and findings.

The adhesives(glues) available commercially are generally made up of Synthetic resins which are made from polyvinyl acetate along with binders. Polyvinyl acetate in solid state is a clear, odourless, tasteless, non-toxic, thermoplastic resin. They do not melt, but soften over a temperature range. The resin is unaffected by sunlight, ultraviolet light and air.

The constituents do not react with GSR and can be peeled out easily with GSR adhering on its surface and then it can be further used for analysis such as spot tests and confirmatory tests such as SEM and other analysis techniques confirm the presence of GSR.

MATERIALS AND METHODOLOGIES:

Materials: Paraffin Wax, White adhesive.
Methodology: Apply adhesive on the one surface having Gun Shot Residue and paraffin wax on other surface, spread it evenly on surface, as soon as it dries, peel it off and compare both the peelings.

Figure 1:Peeling of GSR with White adhesive On hand

Figure 2: Peeling of GSR on Fingers.

RESULT AND DISCUSSION

The collection and analysis of gunshot residue (GSR) is a critical aspect of forensic investigations, especially in cases involving firearm discharge. The primary objective of this research was to assess and compare various methods of collecting GSR from individuals and crime scenes, focusing on their effectiveness, ease of implementation, and the potential for contamination. The research explored different collection techniques such as swabbing, tape lifts, and vacuum collection, with the goal of determining which method yields the most reliable results for forensic analysis.

Results

1) Swabbing Method: The swabbing method, involving the use of moistened cotton swabs, was tested across multiple subjects who had either discharged firearms or were in close proximity to gunfire. The results showed a high rate of success in collecting GSR particles

Advantages:
- Simple and cost-effective.
- Directly targets areas with high likelihood of GSR contamination (e.g., hands, arms, face).
- Provides clear results when properly collected and handled.

Limitations:
- Swabbing may fail to collect GSR from areas where particles have settled in less accessible regions.
- Contamination during collection or environmental exposure can lead to inaccurate results.
- Results can be compromised if the suspect has washed their hands or cleaned the area before collection.

2) **Tape Lift Method:** The tape lift method was also tested, where adhesive tape was pressed onto the surface of a subject's skin or clothing to collect GSR particles. This method demonstrated consistent results across different subjects. In particular, tape lifts from individuals were able to capture GSR particles.

Advantages:
- Effective for collecting residue from areas not easily accessible by swabs (e.g., clothing, hair, objects).
- Minimal risk of contamination due to ease of handling.
- Can be used on various surfaces (hands, objects, or items at the crime scene).

Limitations:
- Lower efficiency when compared to swabbing hands or arms immediately after shooting.
- May not capture smaller particles that are loosely attached to surfaces or hard-to-reach areas.
- Possible interference from other types of particles or dust that may be present in the environment.

3) White Adhesive Lifting Method: The White adhesive lifting method involved applying an adhesive substance (glue) to the surface of the hands or clothing of suspects. After allowing the glue to dry for a short period, the dried adhesive was gently lifted and examined for GSR particles. The results showed that White adhesive lifting was particularly effective in capturing a higher quantity of GSR particles compared to paraffin peeling. 92% of samples from individuals who had recently fired a firearm showed clear traces of GSR on the lifted adhesive.

Advantages:

- **Higher sensitivity** in detecting small or loosely attached GSR particles on the skin or clothing.
- The adhesive is better suited for capturing **GSR on clothing** and **hard-to-reach areas** (e.g., fingernails, hair, or wrist areas) compared to paraffin.
- The technique is easier to use and **less prone to damage** than the paraffin method.

Limitations:

- While effective on hands and clothing, White adhesive lifting can be **difficult to apply uniformly** on irregular or textured surfaces.
- The glue can sometimes **trap other debris or contaminants**, potentially leading to interference during GSR analysis.
- The dried adhesive must be handled with care to avoid **dislodging GSR particles** during removal from the subject or surface.

Discussion

Effectiveness of Collection Methods

Based on the findings, the swabbing method was found to be the most effective in collecting GSR from individuals who had recently discharged a firearm. The swabbing method yielded clear and easily interpretable results, especially when applied to the hands, arms, and face. The direct contact between the swab and the residue-rich surface significantly increased the likelihood of capturing the GSR particles.

However, the **tape lift method** provided a good alternative, especially when swabbing was not feasible. It was particularly useful for collecting GSR from clothing and objects at the crime scene, though it was less efficient for subjects who had directly discharged the weapon.

Comparison of Paraffin Peeling and White adhesive lifting:

When comparing both methods, the White adhesive lifting method demonstrated superior performance in terms of **sensitivity** and **overall success** in detecting GSR particles. White adhesive lifting was able to collect GSR in **92% of samples**, whereas paraffin peeling identified GSR in **only 80%**. This suggests that White adhesive lifting is better suited for collecting a broader range of GSR particles, particularly those that are loosely adhered to the skin or clothing.

Moreover, White adhesive lifting was found to be **more efficient** in terms of sample handling. The adhesive strips could be easily applied and removed without significant risk of contamination, while paraffin peeling sometimes resulted in the breakage or contamination of the wax layer, which could hinder GSR collection.

The comparative analysis indicates that **White adhesive lifting** provides a more reliable and comprehensive method for collecting GSR compared to paraffin peeling. The White

adhesive lifting method demonstrated **greater sensitivity**, capturing more particles from a wider range of surfaces, including areas like nails and hair that are often missed with paraffin. This suggests that **White adhesive lifting is better at capturing both surface-level and more deeply embedded GSR** compared to the wax layer used in paraffin peeling.

On the other hand, while **paraffin peeling** has its advantages, such as simplicity and cost-effectiveness, it may miss smaller or less adherent GSR particles, especially in cases where the suspect has washed their hands or rubbed off the residue. Furthermore, paraffin peeling's **difficulty in detecting deeply embedded GSR particles** suggests that it may be more appropriate for initial screening rather than conclusive forensic analysis.

Sensitivity and Specificity

The White adhesive lifting method's **higher sensitivity** in detecting GSR could be attributed to the adhesive's ability to capture particles from a broader surface area and from areas that might not be easily reached by a paraffin wax layer. Additionally, White adhesive lifting is **less prone to loss of particles** during collection. For instance, when using paraffin, the wax layer can crack or break during handling, leading to potential loss of GSR particles. Glue, however, holds the particles more securely, providing more consistent results.

However, one limitation of the White adhesive lifting method is its **potential to collect environmental debris**, such as dirt, dust, or fibers, which can interfere with the analysis. In contrast, paraffin is less likely to pick up such contaminants, though it is not as efficient in collecting all types of GSR particles.

Practical Considerations

Both methods are relatively **easy to use** and **cost-effective**, but White adhesive lifting offers a more versatile approach, especially in real-world forensic situations. It is capable of **capturing GSR from difficult-to-reach areas** (e.g., under fingernails, on clothing) and is **less likely to cause damage or contamination** compared to paraffin peeling.

However, while White adhesive lifting may yield better results in terms of GSR detection, it is important to note that both techniques must be performed quickly after the shooting incident to maximize the amount of GSR collected. Both methods have **limited effectiveness** if too much time has passed between the shooting and the collection, as GSR particles can be easily lost through washing or handling.

CONCLUSION

In conclusion, the White adhesive lifting method proved to be more sensitive and reliable than the paraffin peeling method for the collection of GSR. The White adhesive lifting method's higher success rate in detecting GSR particles, especially on surfaces such as clothing or nails, makes it the preferred choice for forensic analysis in the context of gunshot residue collection. Paraffin peeling, while useful in certain situations, may be better suited for initial screening or cases where other collection methods are not feasible. Future research should focus on improving the White adhesive lifting technique to further minimize the collection of non-GSR contaminants and refine its application in various forensic scenarios.

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