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Study of 9mm Improvised Pistol Pattern & Gunshot Residue with respect to Different Range

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***Abstract*—** Armed violence is quite common in India and among the other top states; Delhi and its National capital region (NCR) play an imperative role when it comes to seizures of the country made firearms. Thus, Forensic firearm examination of gunshot residue (GSR) has become indispensable. This study presents the characteristics of the seized semiautomatic 9mm Improvised pistol and the gunshot pattern formed on the cloth target after firing in Forensic Science Laboratory, Delhi, India.
This study also emphasizes the analysis of GSR particles deposited on the cotton cloth by Improvised Semiautomatic Pistol using standard ammunition at different shooting distance (5cm & 10cm). The collection and analytical method allowed elemental detection of Sb, Ba, Cu, Pb, and Ni on ppm level by Atomic Absorption Spectroscopy (AAS) analysis.
In this study we observed that when the muzzle diameter and barrel length were constant, the gunshot pattern varied whereas for gunshot residue, out of all the five elements (Sb, Ba, Cu, Pb, and Ni), only the amount of Sb, Pb and Ni were seen to be increased with increased range from 5cm to 10cm.

Keywords - Gunshot residue, Gunshot pattern, Atomic Absorption Spectroscopy.

I. INTRODUCTION

The use of country made guns or 'Desi-Kattas' nominated as India, for criminal activities are rising in an exponential manner in India [1].

Even though, India is regarded as a nation having one of the toughest gun control legislations in the world, Indian Arms Act, 1959 has very stern rules for granting gun licenses [2].

According to a brief released by Small Arms Survey, out of 8 top dangerous megacities in India; 5 were from the state of Uttar Pradesh. Meerut was on the top of the list, which is about 70 Km from National capital, New Delhi [3].

A study revealed, there are about 3, 00,000 illegal firearms in the National capital [4]. In the year 2011, in Delhi there were 63 murders being committed by firearms and 90% of these were from illegal ones [3].

The total estimated civilian owned firearms in the whole world is about 650 million out of which India accounts for approximately 40 million. What comes as a shocker and is mindboggling to know, out of these just 6.3 million or 15.75% are licensed firearms, the rest are unlicensed, illegal guns [5]. These may be country made guns called "Desi-Kattas" or factory-made guns smuggled across the international border.

And even though "Desi-Kattas" are choice of criminals in India, it's observed that little systemic research has been conducted in scientifically analyzing the problem. We cannot depend on foreign research, since the problem is India centric. In order to sensitize government about this hazard, a multi-centric, multi-disciplinary approach is required, which if not reduced will mushroom into a major crisis. Very few literatures are available on the mechanism and features of country made firearm [6-12]. Thousands of illegal homemade and factory made firearms such as .315", .303", 12 bore and 9mm etc. are seized and brought to Indian Forensic laboratory for further investigation.

There is always an increasing pressure from the judicial system to identify an ammunition type, and hence the

weapon type which may have been involved in an incident based on GSR (Gunshot residue) collection [13].

Apart from the physical examination of the firearm received for investigation it's important to analyze the pattern formed due to firing. With different types of improvised firearms and its unique characters, the patterns observed would be unique as well. Gunshot pattern plays a vital role for the range as well as pattern analysis but very little credible research was done on the same. The pattern of GSR is significantly influenced by various factors such as different muzzle-to-target angles, firing distance, type of ammunition and weapon parameters, caliber and barrel length [14].

It is specious that collecting cloth evidence bearing GSR has more potential for providing incriminate evidence in some cases than bare hand sampling. GSR retained on clothing are considerably longer than skin surfaces resulting in a high probability of their detection and identification from that source [15].

If someone is standing close enough to the firing gun, the GSR will appear on the person's clothing. Thus, the estimation of distance from the firearm's muzzle to target material (clothing) may be in an important factor in an investigation [16].

The pattern of gunshot residue may vary with different distances [17]. The GSR generally consists of antimony (Sb), lead (Pb) and barium (Ba) depending upon the cartridge used but in our study we have also included the identification of copper (Cu) and nickel (Ni) as well with the control sample.

To establish physical evidence at the scene of crime, apart from the gunshot pattern, chemical analysis by AAS (Atomic Absorption Spectroscopy) of forensic samples is done to determine different metallic elements and other chemical species. In a gunshot case, the identification of firing is done on the basis of GSR deposit on the clothes of the victim. The evaluation of the GSR helps to identify whether the questioned hole is a gunshot hole.

The objective of the present study is to analysis the physical character, GSR and gunshot pattern which would help in further reference in investigations related to Improvised 9mm firearms.

II. MATERIAL AND METHODS

II.I. Collection of Data

The study was carried out in the ballistics division of Forensic Science Laboratory, Delhi for research purpose. In this systematics study, this 9mm improvised pistol firearm was seized and brought to the laboratory by Crime Branch for thorough examination.

II. II. Physical examination & Photography

Examination of the physical parameters of the pistol along with ammunition used for firing was done in details. Measurement was done by electronic Vernire caliper made by Mitutoyo, Japan. After the examination was done, photograph of the firearm and ammunition was done in the laboratory.

II. III. Firing & Photography

Firing was done in the Forensic Laboratory firing range. Range of 5cm and 10cm from muzzle to target were measured and the fired on a cotton cloth of 34cm*25cm which was fixed on a paper file so that it could hold the impact of the firing. After the firing was done, photograph of the firing pattern on the cloth was done for further examination.

II. IV. Preservation

The cotton cloth sheet was preserved and kept in a zipper pouch to avoid contamination and were labeled accordingly.

II.V. Sample preparation for Atomic Absorption Spectroscopy (AAS)

Three samples were prepared for AAS analysis. A1 was the sample which was fired from 5cm (muzzle to target distance), A2 was the sample which was fired from 10cm (muzzle to target distance and S-C was control sample which was taken from a cotton cloth which was not used for firing.
The samples were soaked overnight in 300ml solution of 5% nitric acid in separate beakers and covered well with foil sheet. Later the beaker was heated in a water bath at 60-70 degree for 10 minutes and left to cool down completely. Then the cloth was gently dabbed with glass rod and filtered with Whatman filter paper and preserved in 300ml reagent bottle.

II.VI. Quantitative GSR analysis

For the quantitative analysis, Atomic Absorption Spectroscopy was used for the analysis of Sb, Pb, Ni, Cu, and Ba elements in the sample solution. The analysis of both the sample solution was carried out by MAARC LABS PVT. LTD., Pune, India.

II.VII. Experimental Conditions

Instrument name: Varian Model No. AA240

Lamp Current-
10mA - Sb and Pb

4mA – Ni and Cu
20mA – Ba

Lamp Frequency-
Sb – 217.6nm
Pb -217nm
Ni -232nm
Cu -324.8
Ba -553.6nm

Standard Solution: 100ppm solution which is prepared by using standard reference material by the laboratory.

III. RESULTS AND DISCUSSION

The present study deals with the examination of seized Improvised 9mm pistol received in the Delhi laboratory for Forensic study. It was observed that crude materials locally available are used for making such firearms by gunsmith. Various parameters of the pistol have been recorded for further examination.

III. I. Physical Examination of 9mm Improvised pistol:

Make: Improvised pistol

Description of Firearm: Black metallic body and silver metal handgrip, empty magazine, magazine release button was on the L.H.S (Left hand side) of the body, fore- back sight present, firing pin was not attached with the hammer.

Safety- Sling- Rifling: Present
Barrel Lock: Present
Direction of twist: Anti-clockwise (L.H.S)
No. of Chambers: six (06)
No. of Lands: six (06)
Firearm Length: 23 cm
Barrel Length: 11.3 cm
Muzzle Diameter: 7.41 mm
Breech Diameter: 8.70 mm

In 9mm Improvised Pistol, the body is made up of iron with a fine finishing which is strong enough to chamber and fire multiple standard 9mm rounds successfully. The firearm is devoid of any logo, code number or any manufacturer's identity, with an unfinished look.

Figure 1: (L.H.S VIEW)

Figure. 2: (R.H.S VIEW)

The action mechanism is semi-automatic. The hand grip was designed by a metal piece and tightened by metallic screws. The trigger is found to be of S-shape and has a magazine release button close to it, on the L.H.S of the body.
Every Improvised firearm is inimitable and this firearm had its own features such as *AUTOMATIC PISTAL, MADE IN USA, NO* (L.H.S of the body), *ONLY FOR ARMY SUPPLAY* (top of the barrel) and *9MM 9 ROUND* (R.H.S- Right hand side of the body) engraved on the firearm body.

III. II. Ammunition:

The cartridges that were being used for firing were standard 9mm cartridges. Bullet was Jacketed (copper alloy) and round nose and cade type was rimless and parallel wall with center fire. The Length of Cartridges was 29.21mm & 27.40mm.

III. III. Gun Shot Pattern:

In this work, we have analyzed three features on the cotton sheet i.e.; blackening (B), tattooing (T) and the hole (H) size for entry and exit [Table 1].

We have studied all the three features for the entry side whereas for the exit side (on file) we could analyze only the exit hole measurement as blackening and tattooing were not observed.

In A1 (entry), the pattern formed on the cloth could be physically observed from naked eyes to be wider than A2 [fig.3][fig.5].
When the pattern was studied in terms of measurements, graphically [fig.7] it was seen that the parameters for length (L) (blackening, tattooing and entry hole) for entry were compared and analyzed. It was seen that the length of A1 was wider for all the patterns, than A2. Whereas for width (W) in A2 [fig.8] it was seen that blackening was more dominant than tattooing and entry hole.
For exit gunshot hole [fig.9], length of A2 is slightly wider than A1 whereas width seems to be the same.
Blackening and tattooing were seen on entry side for both A1 and A2 on the cotton cloth sheet [fig.3][fig.5].

Table 1: Measurements of Gunshot Patterns.

S.NO	DISTANCE (muzzle to target)	ENTRY		EXIT	
		L(cm)	*W(cm)*	*L(cm)*	*W(cm)*
A1	5cm	B-12.6	B-11	0.4	0.6
		T-9.0	T-10.2		
		H- 3.4	H-1.6		
A2	10cm	B-11.0	B-22.2	0.8	0.6
		T-7.4	T-6.1		
		H-0.6	H-0.6		

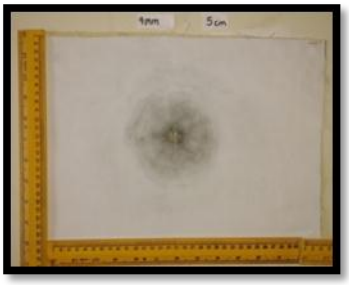

Figure 3: A1 (ENTRY)

Figure 4: A1 (EXIT)

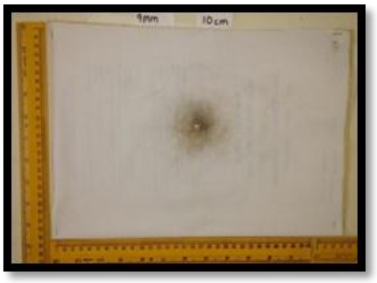

Figure 5: A2 (ENTRY)

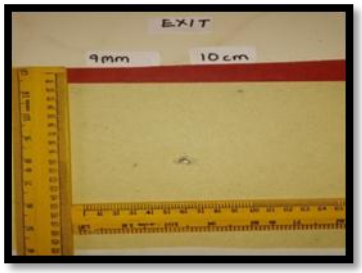

Figure 6: A2 (EXIT)

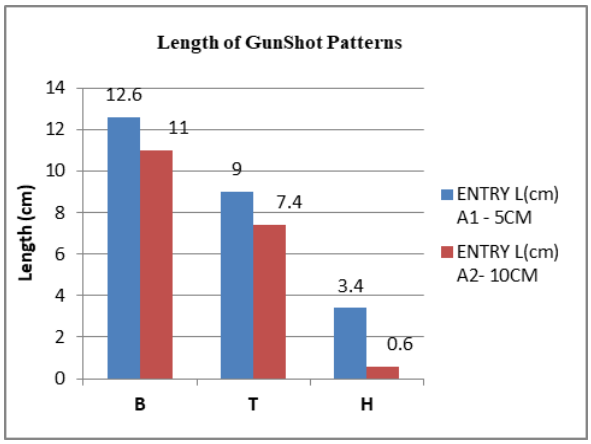

Figure 7: Graphical representation of Length of gunshot pattern.

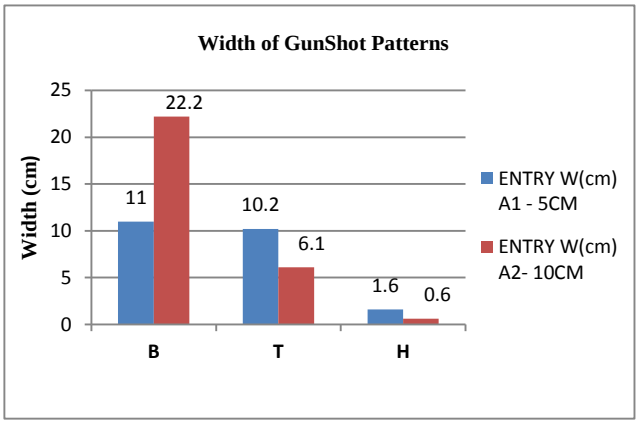

Figure 8: Graphical representation of width of Gunshot pattern.

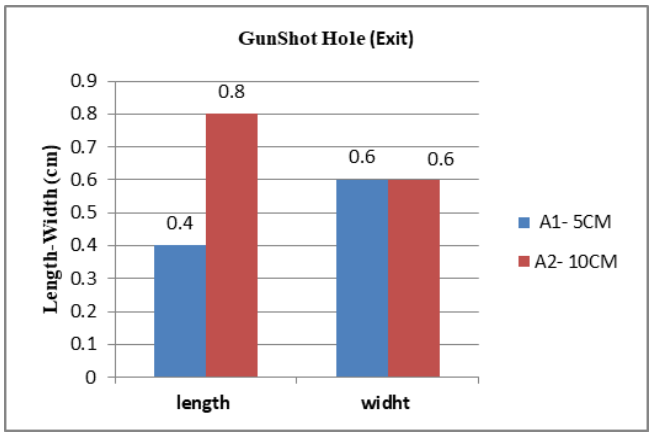

Figure 9: Graphical representation of length and width of exit hole.

III.IV. Gun Shot Residue

We have compared both the samples (A1-A2) having the same barrel length and Muzzle diameter, with control sample for GSR Analysis [table 2].

It was observed in A1 [fig.10] that the concentration (Conc.) of Sb, Ba, Cu and Pb was higher as compared to the control whereas the concentration of Cu was the highest among all the elements. In A2, the concentration of all the five elements (Sb,Ba,Cu,Pb and Ni) are higher as compared to control sample.

The concentration of Pb was the highest among all the five elements.

It was seen that the concentration of elements analyzed according to the range of firing was observed to be inconsistent.

With same barrel lengths(11.3cm) and muzzle diameter (7.41mm) for both the firing, only the amount of Sb, Pb and Ni were seen to be increased with increasing range i.e.; from 5cm to 10cm.

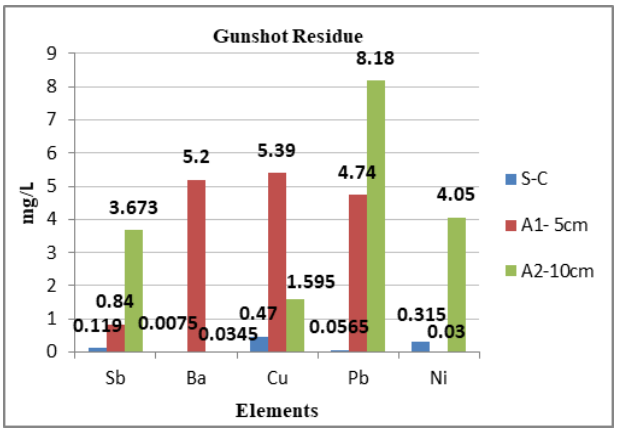

Figure 10: Graphical representation of GSR elements.

Table 2: Quantitative analysis of Gunshot Residue by Atomic Absorption Spectroscopy.

S.NO	SAMPLE	DISTANCE (muzzle to target) (cm)	ELEMENTS Conc. (mg/L)				
			Sb	*Ba*	*Cu*	*Pb*	*Ni*
1.	S-C	CONTROL	0.119	0.0075	0.47	0.0565	0.315
2.	A1	05	0.84	5.20	5.39	4.74	0.030
3.	A2	10	3.673	0.0345	1.595	8.18	4.05

IV. Conclusion and Future Scope

It was studied that the firearm used was unique in itself. Its physical characters and features were distinctive. With the same barrel length(11.3cm) and muzzle diameter(7.41mm), with increasing distance(5cm to 10cm) the gun shot patterns varied whereas for gunshot residue it was seen that out of all the five elements (Sb,Ba,Cu,Pb and Ni), only the amount of Sb, Pb and Ni were seen to be increased with increasing range.

Future scope for improvement in this field of examination is that the investigators should be vigilant about taking the same measured cloth for analysis for a comparative examination for the questioned swab instead of just cutting a piece of cloth around the bullet hole. This will give an improved analysis of the GSR, as it was observed that even in the control samples the elements were present.

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Ms.Karen Isha Sahu pursed Bachelor of Science in 2010, Master of Science in 2012 from SHUATS, Allahabad. She is currently pursuing Ph.D. in Forensic Science from SHUATS, Allahabad since 2012. Her main research work focuses on Forensic Ballistics. She has 6 years of Research Experience.

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