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Study of Estimating Firing Distance Based on Pellets Distribution on Targets from Country made Pipegun

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Abstract

In this article, we demonstrate a method for determination of firing distance based on pellet distribution on targets. This study needs to test firing from the pipegun at various distances viz. 2, 8, 10, 20, 26 ft target to compare gunshot residue and pellets distribution pattern made during the test firing. Smokeless powder particles/gunshot residues (GSRs) on the targets were characterized and analyzed by scanning electron microscopy and energy dispersive X-ray spectroscopy (SEM-EDX). Differences in chemical composition and morphology of GSRs were observed. Gunshot residues were collected from the target by using an adhesive tape. This study revealed that at 2 ft distance blackening and tattooing was seen and after 8 ft distance spreading of lead pellets took place.

Keywords: Pipegun, Pellets distribution, Firing distance, Gunshot residues, SEM.

Introduction

In recent years, public interest in forensic sciences has gained popularity in India as well as in the world. Scientist in firearms identification units are generally asked to compare the suspect firearm with discharged bullets or cartridge cases. Distance determination testing is one of the important tools to determine the distance a firearm was held from the target or victim. When a firearm is discharged, it releases flame, smoke and burnt and unburnt powder particles along with bullet from the muzzle. In addition, metallic lead and other elements contained in the bullet, casing, and primer are expelled from the muzzle of the firearm. These particles commonly known as gunshot residues (GSR), create a circular pattern as they far outward from the muzzle of firearm. The estimation of firing distance is based on the appearance of bullet entrance shot hole and analysis of GSR pattern around the periphery of shothole[1].

Gunshot residue is nothing but cartridge discharge residue which is formed when a cartridge is fired in firearm. Numbers of organic and inorganic compounds that may contribute to the composition of GSR have been reported[2]. There are number of techniques used for collection of GSR sample from the skin, vehicle, windows, doors, clothing, body parts and the surroundings of an incident. These include tape lifts[3], vacuum lifts[4], swabbing[5], glue lifts[6] and nasal collection[7]. Color or spot tests are generally used for the identification of GSR[3]. Identification of inorganic GSR are performed by number of analytical techniques which includes, atomic absorption spectroscopy (AAS)[3,8], inductively coupled plasma spectroscopy (ICP)[9], atomic emission spectroscopy (AES)[10], Scanning electron microscopy (SEM) with X-ray detector[3]. Whereas, gas chromatography (GC)[11], high performance liquid chromatography (HPLC)[4] and capillary electrophoresis (CE)[12] techniques are used for analysis of organic GSR.

Determination of distance based on pellets distribution or powder residue pattern may be a very crucial investigative tool because powder residue pattern may vary significantly. Powder residue pattern not only depends on length of barrel and caliber but also change with changes in primer, powder type and type of propellant[13]. This happens because ammunition manufacturer use different techniques and compounds during their manufacturing processes.

In this work, we describe a method for estimation of firing distance based on pellet distribution. The analysis of lead, antimony and barium were carried out by SEM-EDAX spectroscopy. Also represent relation between the residue amount, residue distribution and the firing distance.

Materials and Methods

The present study was carried out in an indoor shooting range, using 12 bore countrymade pipegun. The standard shotgun used for comparison of physical parameters is manufactured by Indian Ordnance Factory, Kanpur India. The ammunition used for test firing was KF Shaktiman, manufactured by Ordnance Factory, Khadki, India. Six KF 12 bore shotgun cartridges having shot size number 1 were used. Test firing were made at 2, 8, 10, 20 and 26 ft target distance. The targets were made up of sheets of paper having size 22"×19" fitted on the cardboard sheets by staple. A canon EOS 550 D (made in Japan) digital camera was used for photographing the images. The scanning electron microscope (SEM) model Octane Plus equipped with VEGA 3LMU/EDAX (made in USA) was used for detection of GSR particles and its morphology.

Results and Discussion

A device with all necessary action parts and having smooth bored barrel purposely made to fire multiple pellets is knows as shotgun. Pipegun is one of the types of shotgun with a slight difference of cartridge loading mechanism. In pipegun, cartridge was loaded by dismantling the barrel from breech face. In case of shotgun, cartridge was loaded by folding breech face. The effective range or pellet distribution on target depends upon the length of barrel. According to the law, the minimum and maximum length of barrel of shotgun is 18" and 34" respectively[14]. The length of barrel of countrymade pipegun and standard shotgun used in this study are approximately same and maximum according to law. In case of shotguns, determination of effective range of firing is based upon the presence and absence of burning, blackening and tattooing around shot hole and also from dispersion of the lead pellets. This phenomenon depends on the bore size, barrel length, pressure, size of pellets and muzzle to target distance. The determination of firing range of weapon is very important and it helps in deciding whether a criminal case is an act of homicide or suicide.

In this article, the pellet distribution pattern on target that is fired from different distances by pipegun was studied. The physical parameters of countrymade pipegun and standard shotgun are represented in table 1. Data shows difference in the internal diameter and thickness of breech face and diameter and thickness of muzzle end. Figure-1 shows the GSRs and pellet distribution pattern generated on paper target by using country made pipegun. The SEM micrographs and composition for GSR particles discharged from country made pipe gun is represented in Figure-2 and Figure-3 respectively. It was found that the GSR particles are appears as irregular in size and shape. The measurement of external diameter of lead pellets distribution on targets are shown in table 2. This data shows that pellets distribution started after 8 ft distance and increased constantly.

The distribution of pellets on targets also depends upon the diameter of barrel, type of ammunition, type of cartridges, type of shot size and type of choke[15-16]. Choke is constructions which control the shot pattern by reducing the diameter of barrel at its muzzle end. Basically, choke are formed by compressing the bore end or by threading of barrel[17-18]. There are various types of chokes *viz,* standard choke, cone choke, reverse choke and jug choke, half choke, full choke, quarter and zero choke[15].

This study shows that distribution of pellets and GSR pattern vary with distance. The SEM micrographs and composition for GSR particles is represented in Figure-2 and Figure-3 respectively. After visual examination, scanning electron microscopy analysis was done to determine the surface morphology of the GSR particles. To study the SEM, GSR were collected from the target i.e. 2 feet distance from muzzle-target using double based carbon tape SEM stub. Then SEM stub was placed in instrument and scanned to generate an image of GSR particles. The size of GSR particle is varying in diameter. The GSR particle shows difference in shape due to different manufacturing process of ammunition and different mechanism involved in formation of GSR particle in barrel of countymade pipegun[19].

The experimental results revealed that GSR are present up to 2ft distance from muzzle end of countrymade pipegun to target. There is no spreading of lead pellets was observed up to 8ft distance. After 8 ft distance, lead pellets starts spreading slowly. At 10 ft distance, the lead pellets spread with external diameter 10.5 cm. It was also observed that air caution wad was hits on target at different place than that of lead pellets. Table 2 represent the external diameter of lead pellets distribution on targets. External diameter of pellet distribution is fairly matched with the data reported by Arslan et al.[16]. In our study it was observed that, 2.0 cm of pellet distribution at 2 ft distance firing by pipegun is similar to pellet distribution at 75 cm distance firing by 12 bore shotgun with full choke. Similarly, external diameter of pellet distribution at 8, 10 and 20 ft distances firing by pipegun is compatible with previous findings[16-18].

At 2ft and 8 ft distance, individual pellets or lead balls travel closely together with little spread. From 8 ft onwards pellets spread slowly. The wads present in shotgun cartridges play an important role to estimate the range of firing. Basically over shot wad is found nearest up to 6 ft while cushion wad was goes farthest up to 40 meters.

In forensic ballistics point of view, the gunshot residue exiting from the muzzle end of the firearm can give especially useful information regarding distance of firing. As discussed above, such type of countrymade pipegun are frequently used in most of the crime cases and hence this data will be helpful for solving cases in futures. From spread of the shots the, distance of firing can be determined with reasonable accuracy up to the maximum range 26 ft.

Table-1
Physical parameters of country made pipe gun and standard shotgun

Physical parameters	Pipe gun (cm)	Standard shotgun (cm)
Total length	137	126
Length of barrel	84	83
Diameter of muzzle end	1.6	1.73
Thickness of muzzle	0.5	0.23
Diameter of breech end	2.2	1.97
Thickness of breech end	0.2	0.57

Table-2
External diameter of pellet distribution on target

Distance (ft)	2	8	10	20	26
External Diameter (cm)	2.0	9.5	10.5	17.5	35.5

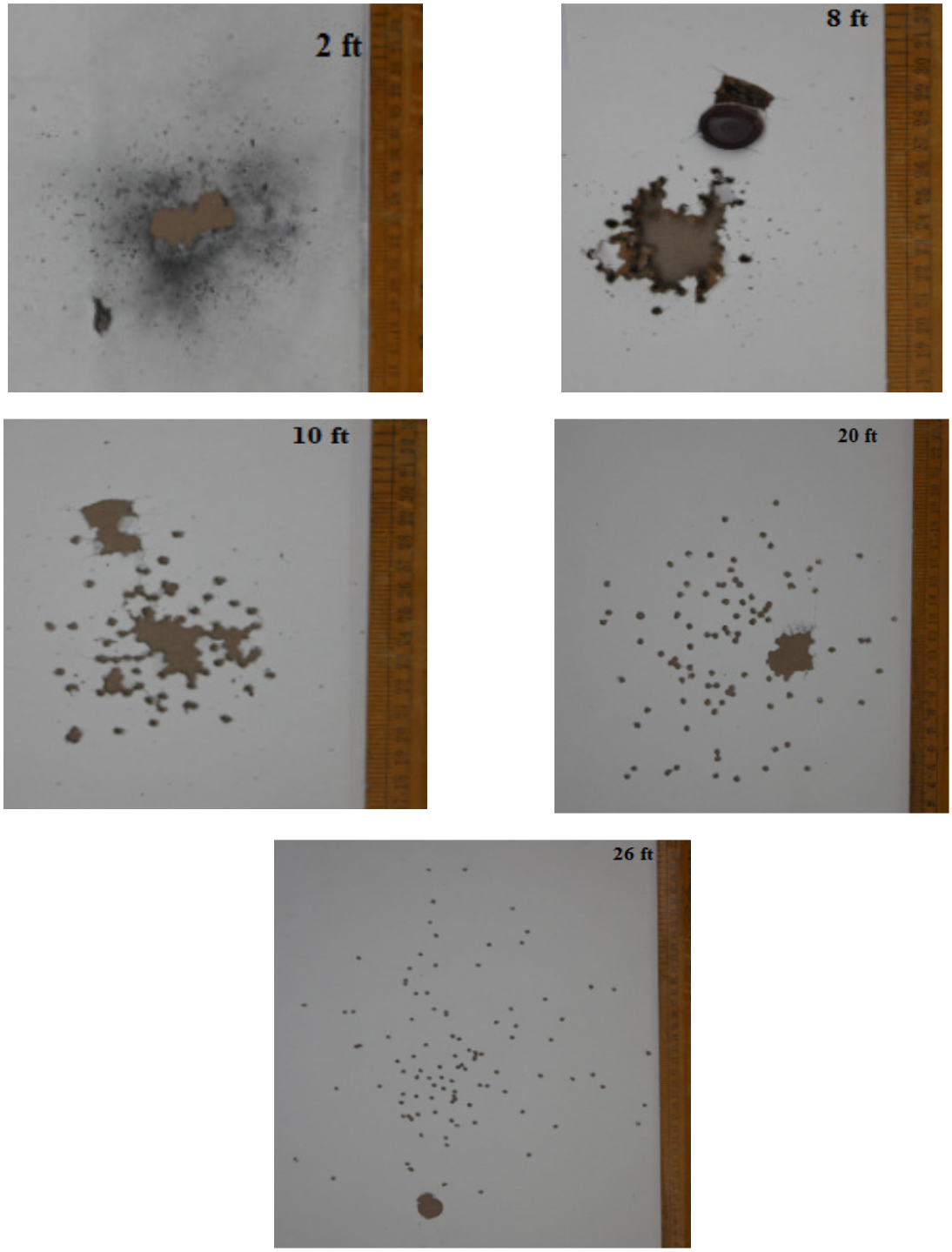

Figure-1
GSRs and pellet distribution pattern generated by Pipegun

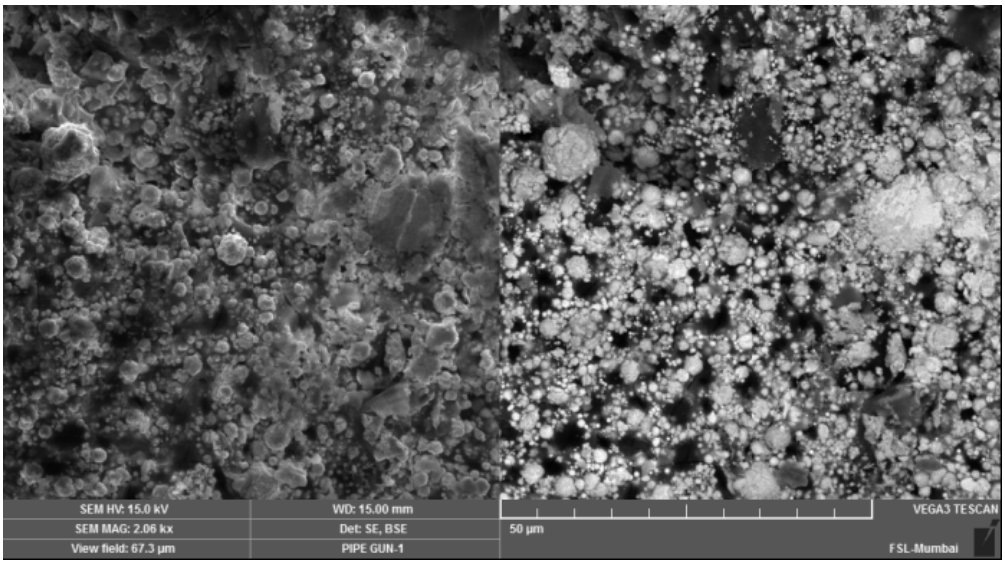

Figure-2
SEM micrographs of GSR particles

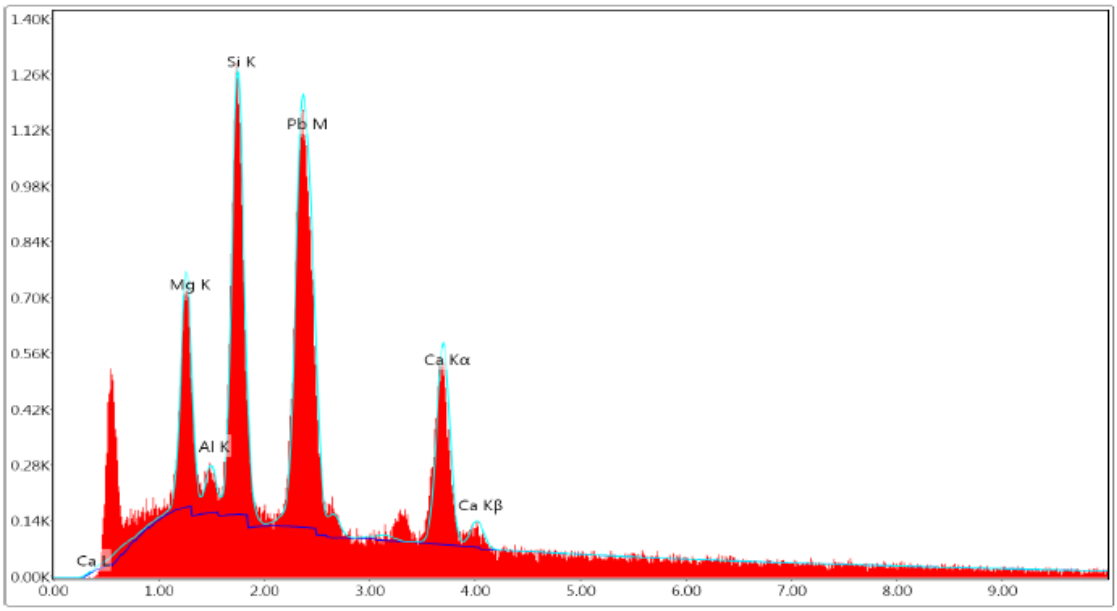

Figure-3
Elemental Composition of GSR particles (EDAX)

Conclusion

In this study we demonstrate the method for determination of muzzle-to-target distance based on pellet distribution and GSRs pattern. The test firing was carried out at 2, 8, 10, 20 and 26 ft distances. The GSRs was analyzed by SEM/EDAX. At 2 ft distance, blackening and tattooing was present. Up to 8ft distance, lead balls travel closely together with little spread. After 8 ft, distribution of lead pellets takes place. This experimental study may use to determine the firing distance from muzzle end to target by reconstructing shooting test.

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