The Effects of Powder, Barrel Length, and Velocity on Distance Determination

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Abstract

Distance determination can be used to show familiarity between shooter and victim, or it could confirm or disprove a suspect's story. This study aims to question whether access to the firearm and ammunition used is really necessary in distance determination. Different barrel lengths, reloading powder type and loads were used to observe differences that may be expected from firearms and ammunition used to fire a bullet of a .357" diameter.

Patterns illustrate a wide range of characteristics with a level of inconsistency. There are a number of factors that could play a role in distance determination, but this study showed a good correlation between powder burn rate and maximum distance of GSR pattern persistence.

Introduction

Frequently, a firearm or the ammunition used in a shooting incident is not present or acquired at the time of the incident, but a bullet may be recovered from the victim. Regardless, investigators are generally interested in the distance of the shooter. Typically, Gun shot residue (GSR) patterns produced using the firearm and ammunition from an incident can be used to determine distance of the muzzle of a firearm to an object through comparative analysis. Patterns typically consist of a mixture of vaporous lead, nitrites, varying degrees of burned gunpowder and other foulings produced by firing a cartridge. According to the guidelines set forth by Scientific Working Group for Firearms and Toolmarks (SWGGUN), it is recommended that the actual firearm and similar ammunition be used.[1] But is this really necessary?

Materials and Methods

Firearms

- Smith & Wesson® .357 Magnum Revolver model 686 8 3/8" Barrel
- Smith & Wesson® .357 Magnum Revolver model 66-1 4" Barrel
- Smith & Wesson® .357 Magnum Revolver model 19-4 2.5" Barrel
- Smith & Wesson® .38 Special Revolver model 10-5 2" Barrel
- Rossi® .357 Lever Action Rifle Model 92 SRC 20" Barrel

Factory Cartridges

- Remington® .357 Magnum 110 Gr. JHP – Lot # J30UB8117
- Winchester® .357 Magnum 110 Gr. JHP – Lot # 1157PD2185
- Federal® .357 Magnum 110 Gr. JHP – Lot # 17A-0228
- Remington® UMC .357 Magnum 125 Gr. JSP – Lot # L.357M12
- Remington® UMC .38 Special 130 Gr. FMJ – Lot # L38S11
- Winchester® .38 Special 148 Gr. LWC – Lot # 27UF50

Reloading Powders and Charge Loads [2-6]

- Hercules Blue Dot®:
  .38 Special Load @ 7.5 Gr.
  .357 Magnum Load @ 12.0 Gr.
- Accurate No. 5®:
  .38 Special Load @ 6.1 Gr.
  .357 Magnum Load @ 11.0 Gr.
- Hercules Unique®:
  .38 Special Load @ 5.0 Gr.
  .357 Magnum Load @ 9.6 Gr.
- Hercules Bullseye®:
  .38 Special Load @ 4.0 Gr.
  .357 Magnum Load @ 8.0 Gr.
- Hodgdon Clays®:
  .38 Special Load @ 3.5 Gr.

Targets

Targets consisted of a 9" x 9" Texwipe® (TX309) Wiper affixed to an 8.5" x 11" Exact® Vellum Bristol 67 lb. Wausau Paper with Scotch® tape. The target was then affixed to a standard cardboard box acting as a baffle board.

Methods

All firearms were fired remotely using a Ransom Rest. Targets were set up at varying distances from the muzzle. An Oehler Model 55 chronograph system was set up between the target and backstop with a spacing of 3 feet.

Each target was set up, the firearm readied and fired remotely. The target was then retrieved and an identification number, cartridge identification, firearm identification, bullet velocity and target distance were notated along the top of the Wausau paper. This process was repeated until the cartridge/firearm combination no longer produced a visible GSR pattern and the next combination was tested.

The Oehler chronograph computed average velocity and standard deviation which was notated per cartridge/firearm combination. All targets were placed in their own manila folder until photo documentation could be completed.

After photo documentation of all targets was completed, targets with unique characteristics were subjected to the modified Griess Test and sodium rhodizonate test to enhance any latent GSR pattern information. [7-8]

Results

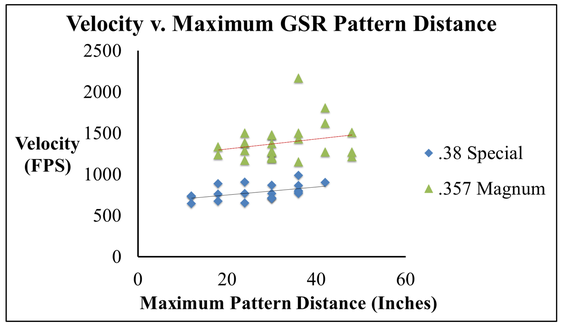

Chart 1 Velocity plotted against maximum pattern distance. Barrel length or ammunition type were not factored in.

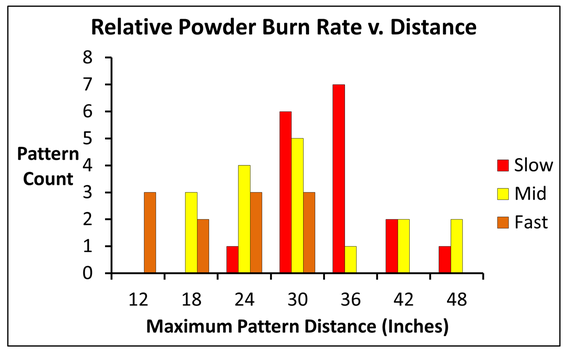

Chart 2 Maximum pattern distances accumulated by relative burn rate of powders. Barrel length, velocity or specific ammunition type were not factored in.

Table 1 Break down of peak distance by ammunition type.

Maximum Distance Representation by Barrel Length							
	.38 Special			.357 Magnum			
	2" Barrel	4" Barrel	8 3/8" Barrel	2.5" Barrel	4" Barrel	8" Barrel	20" Barrel
Remington® 110 Gr. JHP .357 Magnum				48"	42"	48"	
Winchester® 110 Gr. JHP .357 Magnum				30"	30"	30"	
Federal® 110 Gr. JHP .357 Magnum				30"	24"	30"	
Remington® UMC 125 Gr. JSP .357 Magnum				48"	30"	42"	36"
Remington® UMC 130 Gr. FMJ .38 Special	30"	36"	42"				
Winchester® 148 Gr. LWC .38 Special	30"		30"				
Blue Dot®	30"	36"	36"	36"	30"	36"	42"
Accurate No.5®	24"	36"	36"	30"	30"	36"	
Unique®	18"	18"	24"	24"	18"	24"	
Bullseye®	18"	24"	30"	24"	18"	24"	
Clays®	12"	12"	12"				

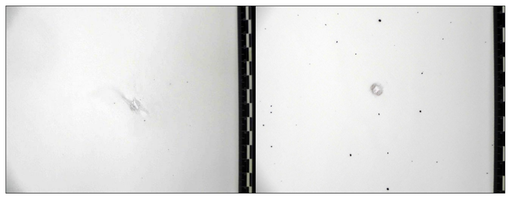

Figure 1 Side by side GSR pattern comparison of 3.5 grain Clays loaded cartridge at 12" *(left)* and a 12.0 grain Blue Dot loaded cartridge at 30" *(right)*.

Figure 2 Side by side pattern presentation of physical pattern alongside Modified Griess reaction produced by Remington® 110 JHP fired from 8" barrel at 48"

Discussion

- Velocity showed only a very weak association and when observing faster loads within a given powder, there is no evident increase in distance *(Chart 1)*
- Powder burn rate shows the highest and most consistent relationship to maximum pattern distance *(Chart 2)*
- Barrel length shows a slight link in .38 Spl loads, but that association breaks down in .357 Mag loads (*Table 1)*

Conclusions

Many trends that are readily visible can be fairly accurate. A contact shot will produce physical tearing and ripping, a gunshot at close range will produce a smoke pattern up to 12" even with the cleanest burning powder, and as a shooter's distance increases, the pattern will typically become wider and less dense.

But maximum pattern distance has been shown to range anywhere from 12" up to 48" with an average of about 30". The strongest association shown was with relative powder burn rate and the faster the relative burning rate of the powder, the lower the maximum distance of a GSR pattern is. Ultimately, these results support the use of specific ammunition, as similar ammunition may produce a different pattern series and maximum distance.

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