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

Daniel Botello, B.S.¹; Dwight Deskins, B.S.²; Jessica Copeland, B.S.²; Catherine G. Rushton, M.S.F.S.¹; Pamela Staton, Ph.D.¹

¹Marshall University Forensic Science Program, 1401 Forensic Science Dr., Huntington, WV 25701
²Kentucky State Police – Eastern Lab, 1550 Wolohan Dr. – Suite 2, Ashland, KY 41102
Question:

Does a firearms examiner need the gun and specific ammo used in a crime to determine distance of the shooter?
The Study

- 357 Magnum revolvers can accommodate for both 38 Special & 357 Magnum
- Velocities recorded using chronograph
- Target is a plain white cotton fabric affixed to cardstock
- Range was varied from 3” to furthest distance that produced a pattern
- Powder type was varied at each range to observe patterns at both max and min loads
Overview

- The Guns
- The Setup
  - Ransom rest
- Reloading
- Chemical Enhancements
- The Data
- Discussion
- Conclusions
The Guns

**Model 686**
- S&W 357 Magnum
- 8 3/8" Barrel Length
- 3.25Lbs
- 7.25 Lb Trigger Pull (DA)
- 2.25 Lb Trigger Pull (SA)
- 6 Round Cylinder

**Model 66-1**
- S&W 357 Magnum
- 4" Barrel Length
- 2 Lbs
- 10 Lb Trigger Pull (DA)
- 4.25 Lb Trigger Pull (SA)
- 6 Round Cylinder

**Model 19-4**
- S&W 357 Magnum
- 2.5" Barrel Length
- 2 Lbs
- 10.25 Lb Trigger Pull (DA)
- 3.5 Lb Trigger Pull (SA)
- 6 Round Cylinder

**Model 10-5**
- S&W 38 Special
- 2" Barrel Length
- 2 Lbs
- 10.5 Lb Trigger Pull (DA)
- 3.75 Lb Trigger Pull (SA)
- 6 Round Cylinder

**Rossi 92 SRC**
- 357 Magnum Lever-Action Rifle
- 20” Barrel Length
- 5.75 Lbs
- 5.5 Lb Trigger Pull
- 11 Round Magazine Capacity
Quick Disassemble
Disassemble Continued
The Setup
Ransom Rest
Reloading
Reloading Cont...
Modified Griess Test:

Used to measure nitrite residues on a target formed during the burning of smokeless powder.

Simplified Testing Procedures:

- Place desensitized photo paper down glossy side up.
- Place questioned material suspected area face down on top of photo paper.
- Dampen a cheesecloth with 15% Glacial Acetic Acid and place on top of material.
- Use an iron to steam any nitrates from target to photo paper.
- Observe color change.
Sodium Rhodizonate

Used to measure lead particles on the target that are typically produced by the primer charge.

Simplified Testing Procedures:

- Spray Sodium Rhodizonate solution directly onto target and allow to penetrate for 1 minute
  - Results in pink reaction where positive for heavy metals
- Spray buffer solution (pH 2.8) on the target and allow to react.
  - Removes the yellow background color of negative areas
  - Consists of sodium bitrate and tartaric acid
- Spray or drop 5% HCl Acid onto positive areas to indicate presence of Pb
  - Results in purple color change
Overview

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  - Ransom rest
- Reloading
- Chemical Enhancements
- The Data
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Raw Data Summary

- 5 Firearms
- 14 unique ammunition types
- 302 patterns produced
- Minimum Bullet Velocity: 622 FPS
- Maximum Bullet Velocity: 2170 FPS
- Shortest Maximum Distance: 12 inches
- Longest Maximum Distance: 48 inches
- Furthest distance target cloth was carried: 133 inches
Pattern Variation

Clays 38 Special @ 18”

Blue Dot 357 Magnum 18”
Clays Series Comparison

Clays 3.5 Grains @ 3”
Visual Comparison

Remington UMC 125 SJ @ 3”
Clays Series Comparison

Clays 3.5 Grains @ 12”
Maximum Distances

Blue Dot @ 36”

Remington 110 JHP @ 48”
## Raw Data 38 Special

<table>
<thead>
<tr>
<th>38 Special Velocity Stats (Feet per second)</th>
<th>Minimum Velocity</th>
<th>Maximum Velocity</th>
<th>Velocity Spread</th>
<th>Average Velocity</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Barrels</td>
<td>622</td>
<td>1003</td>
<td>381</td>
<td>796</td>
</tr>
<tr>
<td>2” Barrel</td>
<td>622</td>
<td>788</td>
<td>166</td>
<td>696</td>
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<tr>
<td>4” Barrel</td>
<td>676</td>
<td>937</td>
<td>261</td>
<td>797</td>
</tr>
<tr>
<td>8 3/8” Barrel</td>
<td>721</td>
<td>1003</td>
<td>282</td>
<td>882</td>
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## Raw Data 357 Magnum

<table>
<thead>
<tr>
<th>357 Magnum Velocity Stats (Feet per second)</th>
<th>Minimum Velocity</th>
<th>Maximum Velocity</th>
<th>Velocity Spread</th>
<th>Average Velocity</th>
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<tbody>
<tr>
<td>All Barrels</td>
<td>1125</td>
<td>2170</td>
<td>1045</td>
<td>1436</td>
</tr>
<tr>
<td>2.5” Barrel</td>
<td>1125</td>
<td>1352</td>
<td>227</td>
<td>1236</td>
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<tr>
<td>4” Barrel</td>
<td>1210</td>
<td>1510</td>
<td>300</td>
<td>1329</td>
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<tr>
<td>8 3/8” Barrel</td>
<td>1316</td>
<td>1710</td>
<td>394</td>
<td>1477</td>
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<td>20” Barrel</td>
<td>1749</td>
<td>2170</td>
<td>421</td>
<td>1956</td>
</tr>
</tbody>
</table>
GSR Visual Patterns: Velocity

Velocity v. Distance

0 10 20 30 40 50 60
0 500 1000 1500 2000 2500

Velocity (FPS)

Maximum Pattern Distance (Inches)

- .38 Special
- .357 Magnum

Linear (.38 Special)
Linear (.357 Magnum)

\[ y = 4.8356x + 652.54 \]
\[ R^2 = 0.2273 \]

\[ y = 6.131x + 1185.3 \]
\[ R^2 = 0.0573 \]
Pattern v. Barrel Length
GSR Visual Patterns: Barrel Length

Barrel Length v. Distance

<table>
<thead>
<tr>
<th>Pattern Count</th>
<th>2&quot; Barrel</th>
<th>4&quot; Barrel</th>
<th>8 3/8&quot; Barrel</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>18</td>
<td>3</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>24</td>
<td>2</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>30</td>
<td>4</td>
<td>6</td>
<td>4</td>
</tr>
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<td>36</td>
<td>3</td>
<td>5</td>
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<td>42</td>
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<td>4</td>
<td>2</td>
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<tr>
<td>48</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>
# GSR Visual Patterns: Powders

## Maximum Distance Representation by Barrel Length

<table>
<thead>
<tr>
<th>Powder Type</th>
<th>38 Special</th>
<th>357 Magnum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2&quot; Barrel</td>
<td>4&quot; Barrel</td>
</tr>
<tr>
<td>Remington 110 JHP 357 Magnum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Win 110 JHP 357 Magnum</td>
<td></td>
<td>30&quot;</td>
</tr>
<tr>
<td>Fed 110 JHP 357 Magnum</td>
<td></td>
<td>30&quot;</td>
</tr>
<tr>
<td>Rem UMC 125 JSP 357 Magnum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rem UMC 130 FMJ 38 Special</td>
<td>30&quot;</td>
<td>36&quot;</td>
</tr>
<tr>
<td>Winchester 148 LWC 38 Special</td>
<td>30&quot;</td>
<td>30&quot;</td>
</tr>
<tr>
<td>Blue Dot</td>
<td>30&quot;</td>
<td>36&quot;</td>
</tr>
<tr>
<td>Accurate No.5</td>
<td>24&quot;</td>
<td>36&quot;</td>
</tr>
<tr>
<td>Unique</td>
<td>18&quot;</td>
<td>18&quot;</td>
</tr>
<tr>
<td>Bullseye</td>
<td>18&quot;</td>
<td>24&quot;</td>
</tr>
<tr>
<td>Clays</td>
<td>12&quot;</td>
<td>12&quot;</td>
</tr>
<tr>
<td>Relative Burn Rate</td>
<td>Minimum Load</td>
<td>Maximum Load</td>
</tr>
<tr>
<td>------------------------------</td>
<td>--------------</td>
<td>--------------</td>
</tr>
<tr>
<td>Remington 110 JHP 357 Magnum</td>
<td>Mid</td>
<td>9.08 Grains</td>
</tr>
<tr>
<td>Winchester 110 JHP 357 Magnum</td>
<td>Mid</td>
<td>9.02 Grains</td>
</tr>
<tr>
<td>Federal 110 JHP 357 Magnum</td>
<td>Mid</td>
<td>9.64 Grains</td>
</tr>
<tr>
<td>Remington UMC 125 JSP 357 Magnum</td>
<td>Slow</td>
<td>17.54 Grains</td>
</tr>
<tr>
<td>Remington UMC 130 FMJ 38 Special</td>
<td>Mid</td>
<td>4.88 Grains</td>
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<tr>
<td>Winchester 148 LWC 38 Special</td>
<td>Fast</td>
<td>2.7 Grains</td>
</tr>
<tr>
<td>Hercules Blue Dot</td>
<td>Slow</td>
<td>7.5 Grains</td>
</tr>
<tr>
<td>Accurate No. 5</td>
<td>Slow</td>
<td>6.1 Grains</td>
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<tr>
<td>Hercules Unique</td>
<td>Mid</td>
<td>5.0 Grains</td>
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<tr>
<td>Hercules Bullseye</td>
<td>Fast</td>
<td>4.0 Grains</td>
</tr>
<tr>
<td>Hogdgon Clays</td>
<td>Fast</td>
<td>3.5 Grains</td>
</tr>
</tbody>
</table>
Burn Rate?
Powder Burn Rate Correlation

**Powder Burn Rate v. Distance**

- **Pattern Count**
- **Maximum Pattern Distance (inches)**

- **Slow**
- **Mid**
- **Fast**

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- 0
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8

- 12
- 18
- 24
- 30
- 36
- 42
- 48

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**Legend**:
- Red: Slow
- Yellow: Mid
- Orange: Fast
Conclusions

- Velocity may play a small role, but overall not a major factor.
- Barrel length shows some correlation in reloaded 38 special, but not 357.
- Powder burn rate shows the highest correlation to maximum distance achieved.
  - Slower powders will persist longer and have patterns at further distances.
  - Faster powders will burn out sooner and do not produce patterns at further distances.
- Examiner would expect to see a smoke pattern up to 12”.
  - Beyond 12” pattern results are variable with ammo and gun used.
Other factors

- These patterns were produced under laboratory conditions and were not exposed to excessive movement, blood or handling.
- Controlled environment also means no environmental factors came into play.
- Targets did not have sturdy backing and this was shown to affect the amount of tearing of target fabric

Rossi 92SRC @ 3” w/ Rem UMC 125 JSP w/o backstop

Rossi 92SRC @ 3” w/ Rem UMC 125 JSP w/ backstop
References


References Continued


Acknowledgements

– Dwight Deskins, Jessica Copeland & the KSP Eastern Regional Forensic Laboratory
– Dr. Staton
– Mrs. Rushton
– Jessica Ybarra
– Alison Quereau
– Scott Doyle
Questions?

http://www.youtube.com/watch?v=QfDoQwlAaXg