Validation of Obturation Marks in Consecutively Reamed Chambers

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ABSTRACT

The identification of fired cartridge cases to a particular firearm based on breech face markings and firing pin impressions has long been accepted in the field of firearms identification. Obturation marks have also been used to make identifications on fired cartridge cases; however, these types of patterns have not been validated as being reproducible and reliable. A nationwide study of obturation marks was conducted using test shots and unknowns from ten consecutively reamed chambers from three different manufacturers. The results show that obturation marks can be used to individualize a firearm.

Introduction

The sidewall of a cartridge case may contain patterns of striations which can be used to determine if a fired cartridge case was fired from a particular firearm. This pattern of markings has been called fireformed chamber striations, or obturation marks. These marks are caused by the expansion of the cartridge case to the chamber walls via the production of gases from the deflagration of the powder in the cartridge and the subsequent extraction of the fired cartridge case after firing. There has not previously been a validation study focused on the chambers of firearms and the obturation marks that they can produce. An article was written in 1987 by Robert Shem regarding obturation marks on rimfire cartridge cases. This article discussed obturation marks as "fireformed chamber striations"1. This article was not a validation study, but rather was an informative article on these types of marks on rimfire cartridge cases.

The purpose of this study was to identify if two or more fired cartridge cases could be identified as being fired from a particular chamber based only on their obturation marks. The chambers used in this study were consecutively reamed.

The following questions were developed for this research:

1. Can trained forensic scientists in the field of firearms identification successfully identify discharged cartridge cases that have been fired from consecutively reamed chambers based only upon obturation marks?

2. Are these obturation marks reproducible and reliable?

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Methods and Materials

Three manufacturers were used for this study: Hi-Point Firearms, Kel-Tec Industries, and Sturm, Ruger & Co. Inc. These manufacturers were chosen based on their willingness to participate and their manufacturing processes. A tour of Hi-Point Firearms in Mansfield, Ohio was provided prior to conducting this study. During this tour, the manufacturing process of the chamber was observed and ten consecutively manufactured chambers were obtained. The authors were unable to travel to Kel-Tec and Ruger to observe their manufacturing processes; however, both companies provided ten consecutively manufactured chambers for this study.

The manufacturing of Hi-Point chambers is a three step process. The first step is the clearing of the chamber, where metal is removed from the interior of the chamber. This reamer is used approximately 5,000 - 6,000 times. The second step is the roughing of the chamber which shapes the metal to the correct size. This reamer can be used 300 - 400 times. The third step is the finishing step, which is the final polishing of the interior of the chamber. This finishing reamer can be used 400 - 500 times. After the polishing reamer has dulled, it is generally used as the roughing reamer. Each of the reamers can be resharpened or discarded; however, the production cost is very low so they are normally discarded.

The manufacturing of Kel-Tec chambers is a two or three step process. The first step is to use a lathe with a cutting reamer. This reamer can be used approximately 90 - 100 times. The second step is a heat treatment. Upon visual inspection, if the interior of the chamber does not look completely finished they will use a Cratex polishing wheel as the final step. When the authors originally purchased the barrels for this project, the third step was done on every chamber.

The manufacturing of Ruger chambers is a three step process. The first step is the roughing of the chamber. This reamer can be used approximately 200 - 400 times. The second step is a finishing reamer, which can also be used approximately 200 - 400 times. The final step is a roller burnishing process. This method of roller burnishing is a cold rolling process without the removal of metal.

Each chamber was utilized to obtain the test shots and the questioned samples. One firearm from each manufacturer (Hi-Point Model C, Ruger Model P89, and Kel-Tec Model P-11) was used for this study; the only parts replaced were the chambers. The cartridge cases were then microscopically compared to identify them to the proper chamber based on their obturation marks. The breech face, firing pin, extractor, and ejector marks were the same on each sample for each respective firearm and could not be used for identification purposes.

A caveat with regard to utilizing obturation marks is being able to exclude manufacturing marks on the ammunition. Another caveat is being able to exclude chambering marks on the ammunition from cycling the cartridge through the firearm and not from discharging the firearm. Therefore, to identify these types of marks as obturation marks and not toolmarks of an unknown origin, it is beneficial to have the firearm submitted for comparison. This allows the examiner to view the manufacturing marks on the cartridge prior to chambering or test firing the cartridge, to view the cartridge once it has been chambered in the firearm, and to view the cartridge case once it has been discharged from the firearm.

Three different brands of ammunition were used in this study: Winchester, Remington and Federal 9 mm Luger caliber with 115 grain full metal jacket bullets. These manufacturers were chosen because they are very common in the United States and are frequently seen in casework.
Each chamber was fired a total of thirty times (ten Winchester, ten Remington, and ten Federal). In addition, each chamber had nine unfired cartridges cycled through it without firing (three of each brand of ammunition). A total of fifty-four validation tests were made. Each validation test consisted of three unknowns and five sets of standards. The five sets of standards each consisted of two fired cartridge cases, one unfired cartridge that was cycled through the chamber, and one unfired cartridge taken directly from the box of ammunition. This allowed the participant to determine which patterns were caused by the discharge of the firearm, which ones were caused by cycling the cartridge through the chamber of the firearm, and which were caused by the ammunition manufacturing process. All the standards and questioned samples were electrically scribed on the inside of the mouth of the cartridge case. The standards were labeled one through ten for the Ruger firearm, eleven through twenty for the Kel-Tec firearm, and twenty-one through thirty for the Hi-Point firearm, for each chamber in which they were fired. The questioned samples were randomly numbered utilizing a computer-based program.

Results

There were sixty-four participants from nineteen laboratory systems nationwide. Twenty-three Ruger, twenty-four Kel-Tec, and seventeen Hi-Point tests were completed. Fifty-five of the sixty-four participants correctly identified all three unknown samples. Six participants correctly identified two of the three unknown samples and had an inconclusive result on the remaining sample. One participant correctly identified one of the unknown samples and had an inconclusive result on the two remaining samples. One participant had inconclusive results on all three unknown samples. One participant incorrectly identified all three unknown samples. As it pertains to this research, the sensitivity is a calculation of the ratio between correct identifications to actual identifications. A ratio of one would mean that all of the identifications within the series of tests were correctly reported as identifications. In this study, the sensitivity is 178/192, or 0.927. A further breakdown of the results follows in Tables 1 and 2.

Conclusion

While the authors acknowledge that one participant incorrectly identified all three of their unknown samples, the authors also have verified that these three same unknown samples were correctly associated by two other examiners during this research project. The authors have therefore determined that this result is due to participant error. This research verifies that obturation marks are reproducible and reliable and that trained firearms examiners can correctly identify fired cartridge cases based on these obturation marks. This research also verifies that the patterns produced by the chambers of these three manufacturers are distinguishable and unique.

Reference

[1] Shem, R.J., “Fireformed Chamber Striations on Rimfire Cartridge Cases,” AFTE Journal, Volume 19, No. 3, July 1987, pp. 282-283.

	Ruger	Kel-Tec	Hi-Point
Total number of tests returned	23	24	17
Number of tests with all three samples correctly identified	21	19	15
Number of tests with two of three samples correctly identified and one inconclusive	1	4	1
Number of tests with one of three samples correctly identified and two inconclusive	0	1	0
Number of tests with three inconclusive	0	0	1
Number of tests with incorrect answers	1	0	0

Table 1

Test #	Number of Times Test Used	Results
Ruger		
1	2	3 ID
		2 ID/1 INC
2	0	
3	1	3 ID
4	2	3 ID
		3 ID
5	1	3 ID
6	1	3 ID
7	3	3 ID
		3 ID
		3 WRONG
8	1	3 ID
9	0	
10	1	3 ID
11	0	
12	2	3 ID
		3 ID
13	2	3 ID
		3 ID
14	1	3 ID
15	2	3 ID
		3 ID
16	1	3 ID
17	1	3 ID
18	2	3 ID
		3 ID

Test #	Number of Times Test Used	Results
Kel-Tec		
19	2	3 ID
		3 ID
20	2	3 ID
		3 ID
21	1	3 ID
22	1	3 ID
23	2	3 ID
		2 ID/1 INC
24	2	2 ID/1 INC
		1 ID/2 INC
25	1	2 ID/1 INC
26	2	3 ID
		3 ID
27	2	3 ID
		3 ID
28	2	3 ID
		2 ID/1 INC
29	1	3 ID
30	0	
31	0	
32	1	3 ID
33	1	3 ID
34	1	3 ID
35	1	3 ID
36	2	3 ID
		3 ID

Test #	Number of Times Test Used	Results
Hi-Point		
37	2	3 ID
		3 ID
38	1	3 ID
39	2	3 ID
		3 ID
40	1	3 ID
41	1	3 INC
42	2	3 ID
		2 ID/1 INC
43	1	3 ID
44	1	3 ID
45	0	
46	0	
47	0	
48	0	
49	2	3 ID
		3 ID
50	0	
51	1	3 ID
52	0	
53	2	3 ID
		3 ID
54	1	3 ID

Table 2