Touch DNA Recovered from Fired and Unfired Shotgun Shells

Anthony J. Saitta
Forensic Science and Chemistry, Henry C. Lee Institute of Forensic Science
Faculty Mentor: Peter R. Valentin BSFS, MSFS

Abstract

A Research Project was designed and conducted to evaluate the possibility of developing *touch DNA* from both fired and unfired, but handled shotgun shells. Modeled after similar research done with different handgun cartridge case materials, we attempted to expand the data gathered on touch DNA and its applications. It was hypothesized that there would be a higher yield of DNA recovery off of shotgun shells than of metallic pistol or rifle cartridge casings. The results of this experiment indicated that we are able to obtain DNA in about 18% of samples which is a similar percentage of samples to the previous research with handgun cartridges.

Introduction

Over the last several years, the sensitivity of DNA testing has increased to the point where DNA profiles can be developed from samples that were previously thought to not have sufficient DNA for testing. DNA can now be developed from surfaces simply from a person contacting that object. Up to this point, forensic scientists would have been limited to looking for DNA in places where a biological fluid was located. This type of transfer has been aptly named *Touch* DNA and it refers to the DNA found in the skin cells shed and trapped in the oils transferred by contact. [4,6] These oils are often what comprise fingerprints and they can be found on almost any surface, which opens up many new places for investigators to look for DNA.

This experiment was designed to test if touch DNA could be recovered and detected from swabbings obtained from both fired and unfired shotgun shells. In this experiment 90 shells from three separate shooters were collected and processed for DNA. Of the 90 shells, a total of 16 shells had detectable levels of DNA on them.

Recent studies have been conducted to determine the minimum quantity of DNA needed to generate both a partial and a full profile, as well as estimate an average amount of skin cells shed and left suspended in fingerprints. Other studies have focused on gathering statistical data on new places investigators should begin testing for touch DNA. These research and experimental efforts were undertaken to improve current investigative procedures increasing the amount of information that can be gathered from physical evidence.

Materials and Methods

A Mossberg 500 Shotgun was used along with Herter's brand 12-gauge shotgun shells. A sample size of ninety shells was chosen so that three separate participants could load and fire fifteen shotgun shells. All participants assembled at a shooting range and loaded each of their own shells to be fired. Similarly, each shooter then loaded and then unloaded fifteen additional shells which were not fired.

Each shotgun shell, whether fired or not, was ejected into individual evidence bags using the normal ejection mechanism for the weapon. Each ejected shell was then labeled for each shooter. Each participant only handled the ammunition when loading to mimic a normal loading process. All ninety samples were secured until ready for DNA testing.

Each shell was carefully removed from the evidence bag and once removed, double swabbed to obtain whatever DNA might be present on the surface. The double swabbing entails using one wet sterile cotton swab followed by one dry sterile cotton swab to sample the entire plastic surface area of the shell for DNA. Once completed, the tips of the cotton swabs were then broken off into sterile 2mL tubes.

Each sample was then subjected to the extraction process with a Qiagen Investigator DNA extraction kit, with a slightly modified lab manual procedure. In order to increase yield, an additional step was performed in using a spin basket to remove all liquid from the swabs. Previous research has shown that this additional step increases DNA recovery rates.

Once each sample was extracted, they were put through forty cycles of PCR DNA amplification along with the usual controls and standards. Once completed, the sampled were then quantified to determine amount of DNA present in each sample. As a result of this process, detectable levels of DNA were found in approximately 18% of the final eighty-eight samples (two samples were contaminated during the extraction process and discarded).

Discussion

Forensic scientists can use a *shedder test* to determine the average amount of skin cells shed from leaving a fingerprint. This information is used to determine the likelihood that someone is to leave touch DNA from contacting an object.

Generally speaking, touch DNA is more difficult to find because of the many variables involved with its transfer and retention, such as how much oil a particular fingerprint will leave, or how many skin cells will be shed in that fingerprint. Furthermore, the length and type of contact as well as the object surface are factors in this process. These, among other variables, make the consistent transfer of DNA difficult to reproduce.[4,6]

In our experiments, we controlled as many variables as were feasible in areas such as the loading and ejection processes. We also adhered to accepted laboratory protocols in the handling of the shells that potentially contained DNA. Despite our best efforts, two samples were contaminated during our experimental process and were eliminated from our study prior to the DNA extraction process. Blank swabs were tested as negative controls for the extraction process, however no unhandled shells were tested. Each negative control had no detectable DNA present during the quantification process.

Quantities of DNA Recovered from Samples			
Unfired	Shooter 1	Shooter 2	Shooter 3
1	3.14E-03	2.35E-03	3.77E-03
2	3.60E-03	2.15E-03	4.24E-03
3	6.98E-03	8.84E-03	n/a
Fired			
1	1.05E-02	1.67E-02	7.74E-03
2	4.30E-03	5.63E-03	1.87E-03
3	3.99E-03	1.86E-03	n/a
Weight in nanograms (1x10^-9 grams)			

Table 1: Displaying the amount of DNA recovered from shells recovered from each participant

Results

Each shooter handled thirty separate cartridges in small groups of only five shells. This was done with the understanding that repeated contact with a surface might decrease the amount of DNA transferred in later contact. Chart 1 displays the breakdown of the 90 shells fired, showing only 88 samples made it to the final quantification and sixteen samples, and approximately 18.18%, had a detectable amount of DNA. This shows that it is possible to recover DNA from both fired and unfired shotgun shell. Conclusions about the composition of the material touch DNA was recovered from, or the effect of the firing process on the degradation of the DNA, cannot be made without further testing.

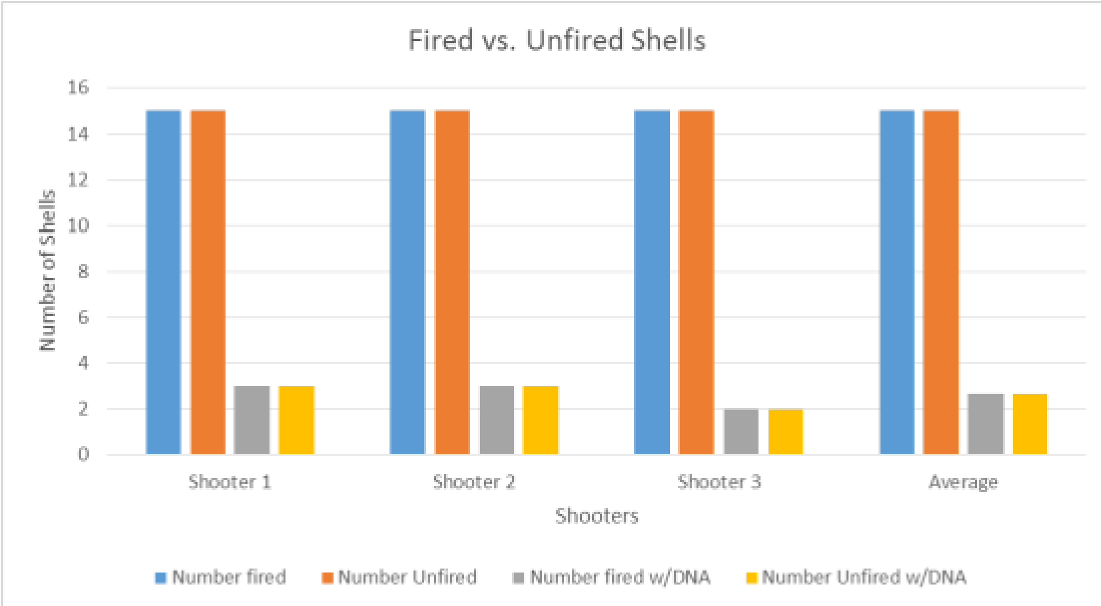

Chart 1: Display of amounts of shogun shells both fired and fired as well as amount verified for containing DNA displayed per participant

Conclusion

Similar studies have been conducted with different variables using different firearms as well as different cartridge casing materials. Another university's results showed that pistol bullet casings made of brass and nickel plated yielded results ranging from 13% to 36% DNA recovered with a similar procedure. The results of this experiment yielded approximately 18.18% DNA recovery. In conclusion, it is possible to recover touch DNA from fired and unfired shotgun shells with a similar rate of success seen for bullet cartridge cases made of nickel and brass. While the percentage of recovery is relatively low, it is evidence that touch DNA can be recovered from both fired and unfired shotgun shells.

References

[1]Gilder, Jason R., Travis E. Doom, Keith Inman, and Dan E. Krane. "Run-Specific Limits of Detection and Quantitation for STR-Based DNA Testing." *Journal of Forensic Sciences* 52, no. 1 (January 2007): 97–101. doi:10.1111/j.1556-4029.2006.00318.x.

[2]Joseph Blozis. "Forensic DNA Evidence Collection at a Crime Scene." In *Forensic DNA Analysis*, 3–18. CRC Press, 2013. http://www.crcnetbase.com.unh-proxy01.newhaven.edu:2048/doi/abs/10.1201/b15361-3.

[3]Joli Bregu, Danielle Conklin. "Analytical Thresholds and Sensitivity: Establishing RFU Thresholds for Forensic DNA Analysis." *Journal of Forensic Sciences* 58, no. 1 (2012). doi:10.1111/1556-4029.12008.

[4]Mottar, Ashley Marie. *OPTIMIZATION OF RECOVERY AND ANALYSIS OF TOUCH DNA FROM SPENT CARTRIDGE CASINGS*. Thesis. Michigan State University, 2014. N.p.: n.p., n.d. Print.

[5]Nunn, Samuel. "Touch DNA Collection Versus Firearm Fingerprinting: Comparing Evidence Production and Identification Outcomes Touch DNA Collection Versus Firearm Fingerprinting: Comparing Evidence Production and Identification Outcomes." *Journal of Forensic Sciences (Wiley-Blackwell)* 58, no. 3 (May 2013): 601–8. doi:10.1111/1556-4029.12119.

[6]Quinones, Ignacio, and Barbara Daniel. "Cell Free DNA as a Component of Forensic Evidence Recovered from Touched Surfaces." *Forensic Science International: Genetics* 6, no. 1 (January 1, 2012): 26–30. doi:10.1016/j.fsigen.2011.01.004.

[7]"The Rifleman's Journal: Equipment: The Making of a Rifled Barrel." *The Rifleman's Journal*. Accessed June 23, 2015. http://riflemansjournal.blogspot.com/2010/09/equipment-making-of-rifled-barrel.html.

Acknowledgements

We would like to thank and acknowledge the Summer Undergrad Research Fellowship for this opportunity to conduct this research. We also would like to thank Carol Withers and the entire SURF faculty team, as well as Dr. Heather Coyle and Dr. Claire Glynn for their assistance with this project. Additionally I would like to thank Peter Valentin for his mentorship and guidance through this project.

.

Anthony J. Saitta is a senior at the University of New Haven enrolled in the Henry C. Lee Institute of Forensic Science seeking a Bachelor's degree of science in both Forensic Science and Chemistry, and set to graduate May of 2016. He plans to continue this research further through the year continuing work on DNA profiling with touch DNA samples. He plans on continuing his education in a graduate program in Forensic Science