Detecting DNA in Magnetic Fingerprinting Powder

Kelly Zhao and Peter Massey, M.Sc.

University of New Haven - Department of Forensic Science

The Henry C. Lee College of Criminal Justice and Forensic Sciences

300 Boston Post Rd. West Haven, CT 06516

Abstract

Deoxyribonucleic acid (DNA) is found amongst all living organisms. Every organism's DNA is unique to themselves. These unique characteristics are being utilized by many, especially prosecutors, and relied on more frequently as evidence in the judicial system.

In many cases, fingerprints are deposited at crime scenes. Often with a fingerprint, the investigators are unable to determine the suspect. Due to the advancement in technology, DNA can be quantified and amplified from the fingerprint residue and then utilized in court.

Because of the improvements in which DNA can be recovered, it can be found fingerprints, and the ease at which contamination can occur when fingerprinting at a crime scene, raises the concern of improper identification of the DNA. Numerous crime scene investigators utilize the same fingerprinting powder and brush or wand every time they try to develop a print. The only changing variable is the tape used to collect the developed impression. Previous work has been cited examining DNA contamination of fingerprint brushes. No previous study before this looked at the magnetic wands, used to apply magnetic fingerprint powders, for their possible contamination influence.

Introduction

DNA, the genetic code, is generally unique to an individual. When discovering minute amounts of DNA, it must be quantitated to determine if it is present and the amount present. Once located, the DNA must be amplified. Amplification means to multiply the amount of DNA in order to obtain a successful profile. With the advancement of technology, DNA can be extracted from friction ridge impressions.

Friction ridge impressions are two dimension images on a surface formed by contact from the friction ridges on the inner surfaces of digits and palmar surfaces of the hands and digits and soles of the foot.[1] They are unique to an individual and do not change over time. Three different types of print: patent, plastic, and latent, can exist. Patent prints are visible and recognizable without enhancements or development. Plastic prints are 3-D images of the fingerprint. Latent prints cannot be seen by the naked eye until they are enhanced.[1]

The most common method utilized to enhance latent friction ridges on a nonporous surface is to use powder to dust the suspected area.[1] This method involves using standard powder with a brush or magnetic powder with a magnetic wand. When using the black or white powder, powder adheres to the filaments of a brush and is gently brushed on the surface until the examiner sees a visible print. The excess powder is gently swept away. Investigators then lift the developed impression. The same concept applies when using magnetic powder, however, the excess magnetic powder is then picked up by a magnetic wand and placed back into the container with the magnetic powder.[2]

Magnetic powder, consisting of iron particles, works in combination with a magnetic wand.[3] Typically, the wand consists of a hollow tube with a magnet at the end of a rod. Pushing the rod down into the hollow tube engages the magnet to attract iron particles and pulling the rod up from the hollow tube will release the iron particles as there is no magnetic attraction at the end of the tube.[3] The magnetic powder stays on the latent print and the magnetic wand is then used to sweep the developed impression removing excess powder.

Materials and Methods

Subject one thoroughly washed their hands with soap and water. Once dry, physical exercise to produce sweat was conducted by rubbing hands together as vigorously as possible for one minute and thirty seconds, resting two minutes, then rubbing the fingers over the Subject's forehead, and deposited the print onto the glass slide by placing the index finger on the flat broad side of the slide. The latent print was then enhanced by gently brushing magnetic powder with the magnetic wand. The excess magnetic powder was placed into a one and a half mL flip top centrifuge tube. Subject one was the control. The same process was repeated for subject two, but a new plastic wand cover was replaced to prevent contamination. Subject three's hands were thoroughly washed with soap and water. The depositing of the latent impression followed identical to that of subject one. The latent print was enhanced by reusing the powder from subject two. The exc ess powder was gathered and replaced into the same tube.

Using a sterile one and a half mL flip top test tube, approximately 100 mg of magnetic powder from the original tube was weighed and placed into the sterile tube. Three hundred sixty µl of Buffer ATL and twenty µl of proteinase K was added and it incubated at fifty-seven degrees C overnight. The tube was then briefly centrifuged. Three hundred µl of Buffer AL was added and vortex for ten seconds. The tube was heated in an orbital incubator at seventy degrees C with agitation at nine hundred rpm for ten minutes. The tube was centrifuged at fourteen thousand rmp for one minute. The supernatant was transferred to a new one point four mL microcentrifuge tube. One hundred fifty µl ethanol was added and vortex for fifteen seconds centrifuged. The lysate was transferred to a QIAamp MinElute column without wetting the rim and centrifuged at eight thousand rpm for one minute. The QIAamp MinElute column was placed in a clean two mL collection tube. The QIAamp MinElute column was opened and six hundred µl buffer AW1 added without wetting the rim and centrifuged at eight thousand rpm for one minute. The QIAamp MinElute column was placed in a clean two mL collection tube, the flow- through discarded. The column was opened and seven hundred µl buffer AW2 added without wetting the rim and centrifuged at eight thousand rpm for one minute. A clean QIAamp MinElute column was placed in a clean two mL collection tube, and flow-through discarded. Seven hundred µl of ethanol was added without wetting the rim and centrifuged at eight thousand rpm for one minute. The QIAamp MinElute column was placed in a clean two mL collection tube, and the flow through discarded. The tube was centrifuged at fourteen thousand rpm for three minutes. The QIAamp MinElute column was placed in a clean one and a half mL microcentrifuge tube and the flow through discarded. The lid of the QIAamp MinElute column was opened and incubated at fifty-six degrees C for three minutes. Fifty µl of Buffer ATE was added to the center of the membrane and incubated one minute at room temperature and centrifuged at fourteen thousand rpm for one minute.[4]

Quantitation was performed to include a ladder to observe a standard curve and amplified to determine if DNA was present.

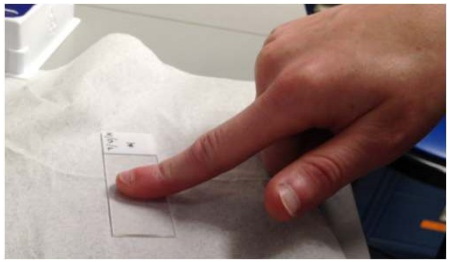

Figure 1: Subject 1 depositing a fingerprint residue.

Figure 2: Gently brushing the magnetic fingerprinting over the fingerprint residue with the magnetic wand.

Results

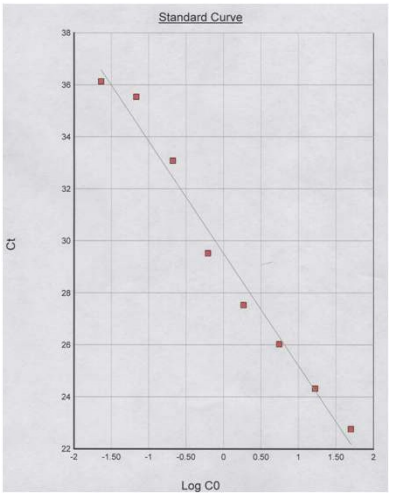

Figure 3: Standard curve from the allelic ladder.

Well	Sample Name	Detector	Task	Ct	Qty
A1	POS	Human	Unknown	13.95	4012.77
		IPC	Unknown	29.99	
A3	50	Human	Standard	22.77	50.00
		IPC	Unknown	31.79	
B1	NEG	Human	Unknown	Undet.	
		IPC	Unknown	28.36	
B3	16.67	Human	Standard	24.32	16.67
		IPC	Unknown	29.03	
C1	1	Human	Unknown	Undet.	
		IPC	Unknown	28.24	
C3	5.56	Human	Standard	26.03	5.56
		IPC	Unknown	28.17	
D1	2	Human	Unknown	Undet.	
		IPC	Unknown	28.29	
D3	1.85	Human	Standard	27.54	1.85
		IPC	Unknown	28.06	
E1	3	Human	Unknown	Undet.	
		IPC	Unknown	28.36	
E3	0.62	Human	Standard	29.53	6.20e-001
		IPC	Unknown	28.09	
F3	0.21	Human	Standard	33.09	2.10e-001
		IPC	Unknown	28.14	
G3	0.068	Human	Standard	35.54	6.80e-002
		IPC	Unknown	28.24	
H3	0.023	Human	Standard	36.13	2.30e-002
		IPC	Unknown	28.32	

Figure 4: Results from the quantitation when using the Applied Biosystems 7500 Real Time PCR.

Discussion

After fingerprinting the subjects, quantitation helped determine the amount of DNA present in the magnetic fingerprinting powder. The results concluded that DNA could not be detected. Therefore, not enough DNA was present in the magnetic fingerprinting powder for the 7500 Applied Biosystems Real-Time PCR to detect it. An allelic ladder was made to use as standard to ensure the primer and master mixed used was working properly. The standard curve (R=1.0), did not give an ideal correlation, but was within the tolerance limits, (R=0.98). This experiment was further supported when amplification of the samples were performed. DNA could not be detected in the amplification process. Amplification is undertaken to replicate the DNA sequence to allow for possible analysis of low quantities of DNA.

While an acceptable result, there are several possible reasons why DNA was not detected. It is very possible that no contamination occurred. The n value of two was statically low, and with such a small n, and total limited weight of substrate, the results may not truly reflect the lack of contamination expected. In a practical situation, the typical jar of magnetic powder used at a crime scene, which may have been used been used hundreds of times, collecting more epithelial cells that are shed, and other cellular constituents normally found in deposited friction ridge residue. The epithelial cells contain the DNA and without the cells, DNA cannot be detected. Thus to further this experiment, a greater n value should be employed, and the study continued using a larger volume of metal filings over a longer time period, which all may contribute to contaminate the magnetic powder. One other variable not examined is the difference in coloring agents since the magnetic powder is available in several different colors.

The lack of detecting DNA could have occurred during quantification. The Applied Biosystems 7500 Real-Time PCR could not detect any DNA, as there might not have been enough DNA sample in the solution. Seventeen and one half µl of DNA sample was utilized and seven and a half µl of the MasterMix was used as a dilution factor, these numbers from a reference experiment that also had minimal amount of DNA detection. It is possible that the amount of suspected DNA sample was too low.

No current protocol exists in which extraction of possible DNA from magnetic fingerprint filings is possible. The protocol utilized in this experiment was adapted from one devised to extract DNA from crushed bone. While this protocol is effective for the crushed bone, it may not have been as effective for the metal filings. The size of the particles may be similar but the makeup of the material is vastly different. The DNA is located in the crushed bone, while the DNA from the metal filings is located on the filings. This difference may be the rationale as to why no DNA was detected as was expected. Further work should be conducted to devise a protocol in which is more attuned to recovering DNA from the metal filings.

Conclusions

While previous studies have had success in quantifying DNA from deposited friction ridge residue, in this experiment It was determined that the amount of DNA was not sufficient enough to be detected. It was also determined that the protocol utilized was designed for a different type of substrate, and that it may have had an overwhelming negative impact in the results. As a result, no specific conclusions can be made that are generalizable in any other situation utilizing metal filings designed to develop latent friction ridges.

Acknowledgements

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