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Dual Recovery of DNA and Fingerprints using Minitapes

Salem K Alketbi[1,2]* and Alsoofi Saif[2]

[1]*University of Central Lancashire, UK*

[2]*General Department of Forensic Science and Criminology, UAE*

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***Corresponding author:** Salem K Alketbi, General Department of Forensic Science and Criminology, University of Central Lancashire, Preston, UK, Dubai Police, UAE

Abstract

Touch DNA and fingerprints are usually found on many items at crime scenes; thus, they are a powerful type of evidence to help investigators to link suspects to crimes committed. Dual recovery of Touch DNA and fingerprints has been previously investigated and proven to be challenging, therefore this study examined the possibility of collecting Touch DNA before fingerprint collection using Scene Safe FAST minitapes. The recovery of Touch DNA from the deposited fingerprints with minitapes (MT) was successful with all the collected samples producing full DNA profiles. Furthermore, the recovery of fingerprints was 90% successful from glass and 100% from stainless steel, with fingerprint recovery not impacted by the collection of DNA or the number of minitape lifts ($p < 0.05$).

Keywords: Forensic science; Trace DNA; Touch DNA; Fingerprint; DNA recovery; SceneSafe FAST minitape; DNA extraction; PrepFiler express BTA; AutoMate express; Quantifiler™ human DNA quantification kit; GlobalFiler™ PCR amplification kit

Introduction

Touch DNA and fingerprints are typically left at crime scenes and are useful to link the suspects to their crimes. Touch DNA usually affected by many variables [1-9], and often both can be collected from touched items such as tools, mobile phones, door or window handles, weapons etc, but it is challenging to collect both trace DNA and fingerprints when they are found on the same surface because the DNA collected from the fingerprints is often found in very small quantities [10]. Furthermore, the powder used to collect fingerprints can interfere and damage Touch DNA, thereby inhibiting DNA profiling. Similarly, fingerprint samples can also be destroyed with DNA recovery methods, such as swabbing or tape-lifting if they are done prior to fingerprinting visualisation. Dual recovery of Touch DNA and fingerprints have been previously investigated by swabbing after lifting fingerprints [11-12], therefore this study examined the possibility of collecting Touch DNA before fingerprint collection using minitapes.

Materials & Methods

Experimental setup & deposition

A participant, previously confirmed as a good shedder, was asked to clean their hands with antibacterial soap, avoid any type of activity for 5 minutes, then charge the fingers of both hands with eccrine sweat from behind their ears to load the fingers with enough DNA [2]. After a further 5 minutes, the participant was asked to touch the surfaces using their index, middle and ring fingers, then thumb by applying medium pressure on two types of surfaces for one minute. The same process was repeated for all the depositions. The test surfaces were non-porous stainless steel (SS; 7.5 x 5cm) and glass (G; 7.5 x 2.5cm) and they were sterilised before use with 2% Virkon (viricidal disinfectant) and ultraviolet radiation (UV) for 20 minutes.

DNA recovery & extraction

DNA samples were collected using SceneSafe FAST™ minitape (1-Tape Kit) (MT) and fingerprints were collected using Black Fingerprint Powder (EVIDENT). Touch DNA was collected in five different ways: one minitape lift (1L), three minitape lifts (3L), six minitape lifts (6L), nine minitape lifts (9L) and fifteen minitape lifts (15L). Fingerprints were collected after the different minitape lifts to determine whether the number of lifts can damage the fingerprint. Next, the lower sticky part of the minitapes was cut directly into extraction tubes and extracted using the PrepFiler Express BTA™ kit with AutoMate Express (using 460µl of lysis buffer instead of 230µl) following the manufacturer's instructions, with a final elution of 50µl.

DNA quantification, amplification, and analysis

Extracted samples were quantified using the Quantifiler® Trio DNA Quantification Kit, QuantStudio 5 Real-Time PCR

(qPCR) and HID Real-Time PCR analysis software v1.3 (Thermo Fisher Scientific) according to the manufacturer's instructions. DNA amplification was performed using a GlobalFiler™ PCR Amplification Kit on an ABI GeneAmp® 9700 PCR System (Life Technologies, Foster City, CA) for 29 cycles. The PCR products were size-separated and detected on an ABI 3500 Genetic Analyzer (Life Technologies) using 1µl PCR product, 9.6µl Hi-Di™ formamide, and 0.4µl GeneScan™ 600 LIZ® Size Standard v2.0 (Thermo Fisher Scientific). Statistical analysis was performed with RStudio using factorial analysis of variance (ANOVA) and Microsoft Excel. Blanks were taken from surfaces after sterilisation and negative controls for the collection and extraction methods, all of which were DNA free when quantified and amplified.

Results & Discussion

The recovery of Touch DNA from the deposited fingerprints with minitapes (MT) was 100% successful as all the collected samples produced full DNA profiles. The amount of Touch DNA collected was dependent on the surface area ($p<0.05$), with more DNA collected from the 7.5 x 5cm SS than the 7.5 x 2.5cm G surface (mean SS = 0.24ng/µl vs. G = 0.09ng/µl). Likewise, the amount of Touch DNA collected was affected by the number of minitapes (MT) lifts ($p < 0.01$), with the amount of collected DNA increasing with more MT lifts (Figure 1). Similarly, the average signal (RFU) was affected by the surface area ($p<0.01$) and the number of minitapes (MT) lifts ($p < 0.01$), with a higher average peak height for SS than G (RFU mean SS = 4788 vs. G = 2623). Also, the average peak height increased with the number of MT lifts (Figure 2). The recovery of fingerprints was 90% successful from the G and 100% from the SS surface (Figure 3). Fingerprints were not impacted by the collection of DNA or the number of minitape lifts ($p > 0.05$) when they were deposited by a participant considered to be a good shedder. Recognisable patterns and features were observed in most fingerprints for database comparison.

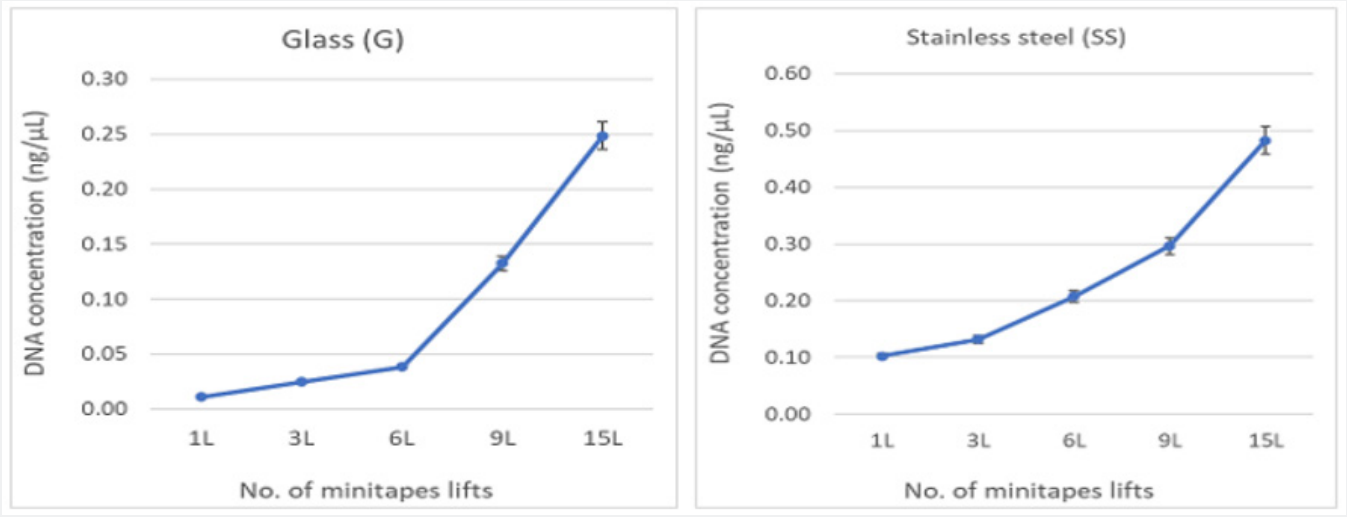

Figure 1: The amount of DNA recovered by minitapes (MT) lifts from deposited fingerprints (n=20) on glass (G) and stainless steel (SS).

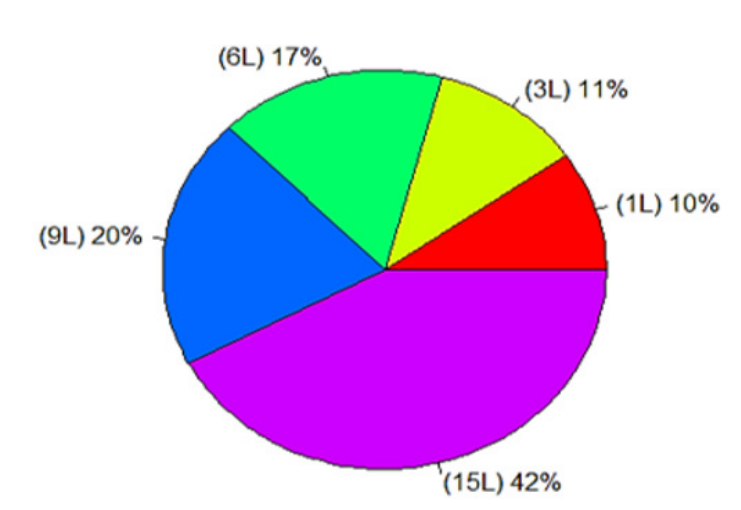

Figure 2: Percentage signal (RFU) recovered by minitapes (MT) lifts from deposited fingerprints (n=20) on glass (G) and stainless steel (SS).

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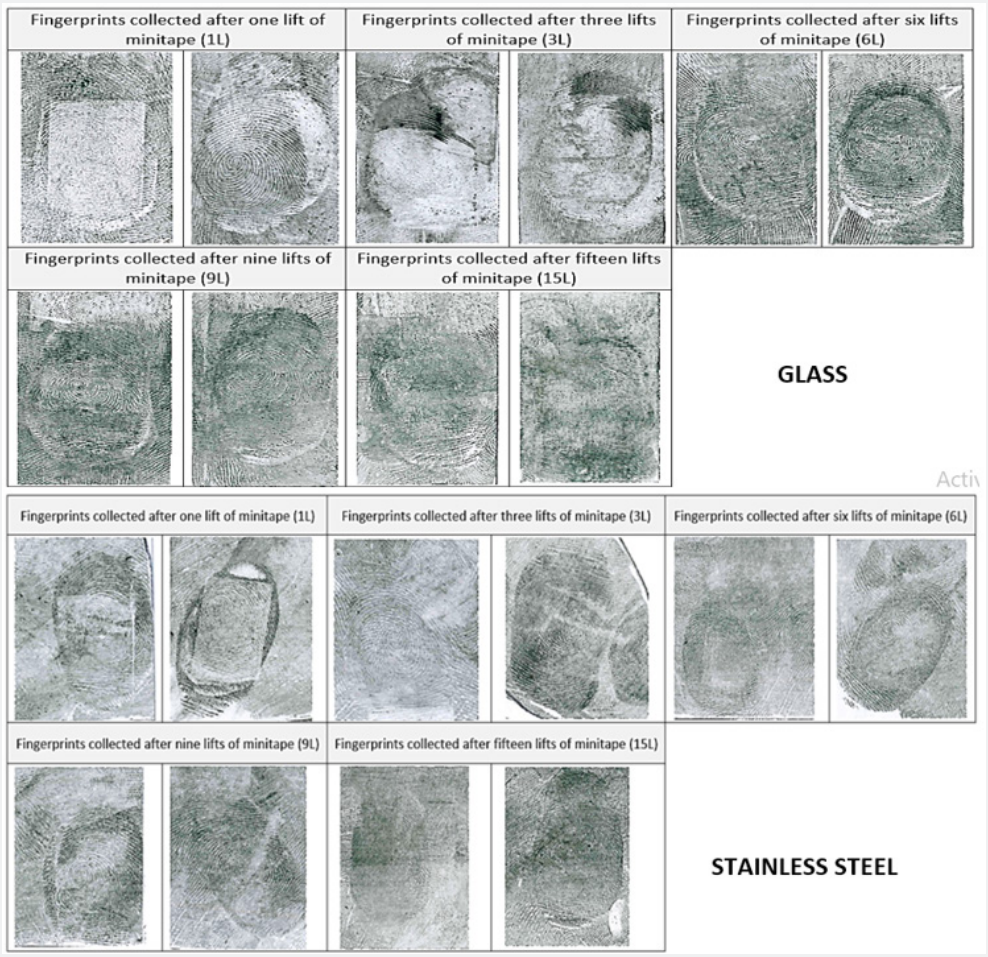

Figure 3: Fingerprints recovered after each minitape (MT) lifts from deposited fingerprints (n=20) on glass (G) and stainless steel (SS) collected by Black Fingerprint Powder (EVIDENT). Fingerprints were collected by revealing them with a dusting of black powder using a brush, then lifted with clear tape and deposited on white backing cards.

Conclusion

Dual recovery of Touch DNA and fingerprints is successful from distinct fingerprints deposited by good shedders on non-porous surfaces with the use of minitapes and Black Fingerprint Powder. The number of minitape lifts to collect Touch DNA does not affect the quality of the fingerprint if performed carefully and using low-medium pressure to avoid smearing the fingerprint. Further studies should be performed on other types of Touch DNA shedders to confirm these results.

Acknowledgement

This study was approved by the General Department of Forensic Science and Criminology in Dubai Police and ethical approval was granted by the University of Central Lancashire's Research Ethics Committee (ref. no. STEMH 912).

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