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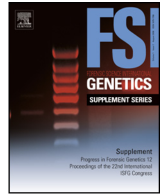

Effect of two different swabs on genetic profiling of enhaced fingerprints

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ABSTRACT

Different studies have proved that skin contact can transfer enough DNA for successful STR typing, the success rate depends on the individual handler, which hand has been used, the activities of the individual prior to touching the object and the handled substrate. In the present study we investigate the effect of fingerprint-enhancement powder methods on subsequent STR profiling from bloodstains and latent fingerprints. The research was conducted into two phases. First we performed a study typing blood traces deposited on five different surfaces, treated with eight types of dactyloscopic powders and using three different DNA extraction methods. In the second part of our study we analyzed latent fingerprints on the same five surfaces enhanced with the eight different powders used in the first part of the study recovered with two different type of swabs (Cotton swabs and 4NGFLOQSSWABS GENETICS-COPAN).

In the first phase of the study a profile was obtained in 92% of the 120 samples analyzed, with the percentage of full profiles of 60%. In the second phase, in 55% of the 80 samples analyzed we obtained a profile, complete in 32.5% of cases, using cotton swabs. With the COPAN swabs in 76.3% of the 80 samples analyzed we obtained a profile, complete in 30% of cases.

The work has demonstrated that DNA profiling can be performed on fingerprints left on different substrates and the nature of the substrate will affect the amount of DNA that can be recovered for DNA typing analysis.

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1. Introduction

Fingerprint technology and DNA analysis are routinely used in the management of crime scene in criminalistic investigation.

With modern PCR based technologies it is possible to type the amounts of DNA that skin contact can transfer for successful STR typing [1–3].

In the last twenty years, in the field of obtaining reliable STR profiling from small amounts of DNA on touched objects, great attention has been paid to the possible interactions between dactyloscopic enhancement methods or bloodstains enhancement methods and DNA typing techniques [4,5].

In criminal caseworks, it may happen that latent fingerprints are not useful for dactyloscopic purposes, because, for example, curve and loop patterns are blurred; latent fingerprints are not commonly used for DNA typing, even if they could be considered useful DNA sources. The main problem in these cases is whether dactyloscopic methods could be used on a surface without interfering with the ability to perform DNA profiling from latent fingerprints or from other biological evidences obtained on the same surface.

2. Material studied, methods, techniques

Five different porous and non-porous substrates (glass, paper, plexiglass, ceramic, metal) were used to investigate biological stains consisting of blood (first phase) and latent fingerprints (second phase). All the surfaces were pre-cleaned and then treated with DNA Remover®.

Four different female were involved as donors of blood and fingerprints (saliva samples were used as positive control).

In the first phase of the study, 8 aliquots of 50 μl of blood were deposited on each surface. All bloodstains were dried at room temperature and then dusted (after 24 h) with 8 different dactyloscopic powders: metal white, metal black, metal grey, magnetic black, magnetic grey, fluorescent pink, fluorescent yellow and fluorescent orange. On each surface, every single bloodstain was treated with one powder method, leaving one bloodstain from each donor untreated as control for DNA extraction. Each dusted bloodstain was sampled with 3 different

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sterile cotton swabs, moistened with sterile water, which were stored at +4 °C until the DNA extraction.

In the second part of the study, fingerprints were placed by the same 4 donors, 30 min after washing their hands. When placing the fingerprints the pressure was subjectively firm and was exerted for 60 s. On each substrate fingerprints were enhanced with the same 8 powders used in the first phase (2 fingerprints with the same powder) and 4 fingerprints for each substrate (one fingerprint belonging to each donor) were used as untreated control for DNA extraction.

Each visualized fingerprint was sampled both with a sterile cotton swab moistened with sterile water and with 4NGFLOQSS-WABS GENETICS-COPAN, then stored at +4 °C until the DNA extraction. In all phases the sampling with the swabs was undertaken within 60 min from the powder dusting.

DNA was extracted from bloodstains using three different methods for each stain: the Chelex method, the Charge Switch® Forensic DNA Purification Kit - Invitrogen™, and the QIAamp® DNA Micro Kit - Qiagen.

In the second part of the study, DNA extraction from enhanced fingerprints was performed with Charge Switch® Forensic DNA Purification Kit - Invitrogen™ and with QIAamp® DNA Micro Kit - Qiagen, with a final eluted volume of 20 μl.

Amplification was performed using the AmpFℓSTR® Identifiler® Plus PCR Amplification Kit (Life Technologies). All PCR reactions were carried out in a GeneAmp® PCR System 9700, 96-Well Gold-Plated (Life Technologies). PCR negative and positive controls were carried through the entire process. PCR was performed following the manufacturer's recommendations, modified by different technical enhancement: reduction of the final amplification volume to 12.5 μl (in the first part of the study) and to 13.5 μl (in the second part of the study), the adding of 1 μl of BSA [1 mg/ml], and additional PCR cycles (34) in the second part of the study.

In the second part of the study the amplification was repeated three times for each sample.

Profiles were generated using a 3130 Genetic Analyzer (Life Technologies). Analysis was undertaken using GeneMapper® ID Software software v 3.2 (Life Technologies).

The previously known profiles of the four donors were always compared to the results.

We performed agarose gel electrophoresis on samples which didn't show any results, with the purpose to find out whether null results were due to an extraction or an amplification failure. Electrophoresis of 5 μl of PCR was performed in 1.0% agarose gel in 1X TBE buffer with 0.5 μg/mL of ethidium bromide to visualize amplicons under ultraviolet. We used 1 Kb Plus DNA Ladder™ (Invitrogen™) as molecular weight marker.

3. Results

Amongst the 120 blood powder-treated specimens, 110 were successfully typed (92%) and 72 showed complete genetic profiles (60%). All obtained alleles conformed to data obtained from the saliva of the respective subjects. The QIAamp® DNA Micro Kit has proved to be the most efficient method in this phase, with 40 typed profiles, among which 26 were complete.

The Charge Switch® Forensic DNA Purification Kit showed good results as well, leading to 40 profiled samples, with 24 full profiles. For bloodstains treated with thin powders, such as magnetic or metallic grey/black, this extraction kit gave a high number of partial profiles.

The Chelex extraction method led to 30 typed samples with 22 complete profiles.

All 20 untreated bloodstains were successfully typed with full profile results.

In the second phase different technical assessments were performed in order to enhance the efficiency of analysis. During the extraction phase we didn't use the Chelex method because in the first phase of the study it gave the lowest number of profiles, and we reduced the DNA-eluted volume to 20 μl. In the amplification step we increased the number of PCR cycles from 28 to 34 and reduced the final amplification volume to 13.5 μl, including BSA addition.

Each DNA sample was amplified three times in order to obtain a consensus profile.

All obtained alleles conformed to data obtained from the saliva of the respective subjects.

With Cotton swabs amongst the 80 fingerprints analyzed, 44 were successfully typed (55%) and 26 showed complete genetic profiles (32.5%).

With the COPAN swabs in 61 of the 80 samples analyzed we obtained a profile (76.3%), and 24 showed complete genetic profiles (30%).

All negative controls, both for bloodstains and for fingerprints, didn't give any results, confirming that there was no contamination.

4. Discussion

For bloodstains, full profile typing seems to be low, at only 60%, especially considering that 50 μl of blood is quite a large stain. This low success rate could be explained by the fact that during the Chelex method extraction we did not obtain a good purification from powders. As a result this method led to the worst results.

Furthermore, it was noted that amongst the ten samples which were not typed, all were extracted using the Chelex method; nine were treated with fluorescent powders and one with black metallic powder. In particular, fluorescent powder shows interference with capillary electrophoresis, enhancing the signal with an overflow in the scale.

For fingerprints we obtained the best results when using the QIAamp® DNA Micro Kit and this kit seems to be the more suitable for typing latent fingerprints enhanced with dactyloscopic powders.

The higher number of complete profiles were obtained in glass and metal plates, probably because these surfaces are smoother than the others, and thus less powder adheres to them.

We performed agarose gel electrophoresis on DNA samples which didn't show any results, with the purpose of finding out whether null results were dependent on extraction or on amplification failure. All DNA samples resulted partially degraded, suggesting that when dealing with low quantity of DNA, as is the case for single fingerprints, dactyloscopic powders could have a direct degrading effect on DNA rather than inhibiting extraction or amplification. From the results obtained it seems that the powders used in latent fingerprint enhancement, rather than having a direct inhibitory effect on extraction and amplification of DNA may cause partial degradation of DNA, thereby reducing the efficiency of amplification reaction.

The higher number of complete profiles obtained with glass and metal surfaces suggested that their characteristics facilitate the recovery of DNA.

The different success rate in typing, using the two different type of swabs (COPAN and Cotton), could be explained with the fact that the greater efficiency in taking the biological material of the COPAN Swabs, may also determine a greater transfer of the dactyloscopic powders that remain in the eluate resulting in a diminished efficiency of amplification, and then yield a lower quality of the profiles.

5. Conclusion

This study proved that it is possible to obtain and type DNA from single latent fingerprints, enhanced with powder-based dactyloscopic methods, in accordance with previous studies. However, despite these results, we think that it should not be forgotten that they were obtained under laboratory conditions, however, in real caseworks there may be still different scenarios that might be more complex than the controlled laboratory condition followed in this study, as for example the time from the stain production and their collection, the amount of biological material left with touching, the cleaning condition of the substrates on which we could find evidence.

Conflict of interest

All Authors disclose any conflict of interest.

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