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The recovery of latent fingermarks and DNA using a silicone-based casting material

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Abstract

There are many techniques available for the recovery of fingermarks at scenes of crime including the possibility of taking casts of the marks. Casts can be advantageous in cases where other destructive recovery techniques might not be suitable, such as when recovering finger marks deposited on valued or immobile items.

In this research, Isomark™ (a silicone-based casting material) was used to recover casts of finger marks placed on a variety of substrates. Casts were enhanced using cyanoacrylate fuming. Good quality marks were successfully recovered from a range of smooth, non-porous surfaces. Recovery from semi-porous surfaces was shown to be inefficient.

DNA was subsequently extracted from the casts using QIAamp® Mini extraction kits, amplified and profiled. Full DNA profiles were obtained 34% of samples extracted.

Keywords: Forensic science; Finger mark; Casting; Isomark™; DNA profiling

1. Introduction

The enhancement of fingermark ridge detail is of paramount importance for the identification of marks deposited at scenes of crime. Much research has been carried out in this area and multiple techniques and methods are available for use, each with their own merits and disadvantages [1].

This study investigated the recovery of fingermarks using Isomark™ (Isomark Ltd., Nuneaton, Warwickshire, UK). Isomark™ is a fast curing silicone-casting material. It was first introduced for the detection of mechanical marks and specifically designed for forensic use. Most significantly, Isomark™ is reportedly non-destructive and can reproduce marks with a resolution of 0.1 μm.

Finger marks at a scene may be distorted, smudged or without enough ridge detail to make a reliable comparison of characteristics. In such cases, it is desirable to obtain a deoxyribonucleic acid (DNA) profile from the finger mark [2]. This study also aimed to ascertain whether it is possible to obtain a reliable DNA profile from the Isomark™ casts of the finger marks.

2. Materials and methods

2.1. Deposition of finger marks

Finger marks were deposited in both a controlled and a realistic manner.

Controlled finger marks were deposited onto the following six substrates: cold aluminium can (stored at 4 °C before fingermark deposition), plastic water bottle, £2 coin, waxy paper cup, 60 W light bulb and a hard plastic mobile phone case (Nokia 3330). Two volunteers were asked to wash their hands using soap and water, and then rubbed their fingers over their face. Five discrete marks (from five separate fingers) were then deposited onto each of the substrates within a designed 5 cm by 4 cm area. Each volunteer repeated the application five times per substrate ($n = 50$), under the same conditions.

Realistic finger marks were deposited on the aluminium can, bottle and cup. None of these substrates were washed before deposition. Two donors took part in this part of the study. The donors did not wash their hands before depositing

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marks. The donors were asked to drink from the can (removed from a refrigerator at 4 °C), bottle and cup as they would normally. 62 prints were subsequently analysed.

In both situations, untouched areas of each surface were sampled as negative controls.

2.2. Recovery and development of finger marks

Isomark™ was dispensed over the marks 1 h after they were deposited and spread using a plastic spreader. After recovery, the marks were left for 1 day before developing. The marks on both the Isomark™ cast and the substrate, after casting, were treated with cyanoacrylate (CNA) adhesive PERMABOND (1.2 g; Permabond Engineering Adhesives Ltd., UK). Items were treated within a MVC 3000 fume hood (Foster and Freeman Ltd., UK). Fuming took place for 20 min at 80% humidity and 120 °C.

After development, items were photographed using an Integrated Rapid Imaging System (IRIS, HOSDB).

2.3. DNA recovery

After the finger marks were recovered and enhanced with CNA, the samples (substrates and casts) were stored at 4 °C for 12 h. DNA extraction was then performed from both sample types.

The surfaces of the substrates were swabbed first with a sterile wet cotton swab (Fisher Scientific UK Ltd., UK). Residual moisture was then recovered by swabbing the surface with a dry cotton swab. Both swab heads were placed into the same 2 ml microcentrifuge tube. DNA extraction was performed using the QIAamp® DNA Mini Kit according to manufacturer's instructions (QIAgen™). The Isomark™ was sliced with a sterile scalpel and the pieces placed directly into a bijou. DNA extracted as above, with a larger volume (1.5 ml) ATL extraction buffer being added in the first step, to cover the Isomark™ cast.

The DNA was concentrated using Microcon® Ultracell YM-100 (Millipore, USA). DNA quantitation was then performed using Quantifiler™ Human DNA Quantification Kit in an ABI PRISM® 7000 (Applied Biosystems, CA, USA).

2.4. DNA amplification and profiling

DNA amplification was performed using the AmpF/STR® SGM Plus® Kit. A 28 cycle amplification was conducted following the manufacturer's protocol, in a 25-μl final reaction volume. The samples were then profiled using an ABI PRISM® 310 Genetic Analyser (both from Applied Biosystems, USA).

2.5. Statistical analysis

Statistical analysis was performed using Statistical Product and Service Solution, Inc. (SPSS, Chicago, IL, USA). Univariate analysis of variance (95% statistical level) was performed on the results in order to determine whether there was significance in the variation obtained. In cases where more than two items were compared, univariate post hoc multiple comparisons (equal variances assumed using Tukey) for observed means was performed.

3. Results

3.1. Finger mark analysis

In order to grade the marks, a classification system was used based on the number of ridge flow and characteristics observed. The marks were given a score between 0 and 8, where 0 being least and 8 the most discriminative.

3.2. Controlled finger marks

The marks deposited in a controlled manner on the six different substrates were recovered using Isomark™. Fig. 1 shows detail from finger marks recovered from each substrate using the Isomark™ and sequentially treated with cyanoacrylic (CNA) fuming.

The quality of the recovered marks was assessed. Table 1 shows the characterisation of the marks obtained from the six substrates.

As can be seen from Table 1, marks of decent quality could be successfully visualised on the Isomark™ casts of marks deposited on most surfaces tested. It was determined that the aluminium can, the bottle, the coin and the light bulb yielded marks of significantly higher quality than those recovered from the foam cup and the mobile phone case ($p < 0.01$).

Table 1
Quality of controlled marks recovered using Isomark™

Substrate	Mark quality (Iso)		Mark quality (Sub)	
	Average score	σ	Average score	σ
Aluminium can	4.2	1.10	2.4	1.34
Base of plastic bottle	4.8	2.05	5.8	2.17
£2 coin	5.0	2.00	6.0	1.87
Cup	0.6	1.34	0.0	0.00
Light bulb	4.0	0.71	3.0	0.00
Mobile phone case	0.0	0.00	0.4	0.89

A score of 0 is the least and 8 is the most discriminate. (Iso) = Marks recovered using Isomark™; (Sub) = marks on substrate after Isomark™ lifting.

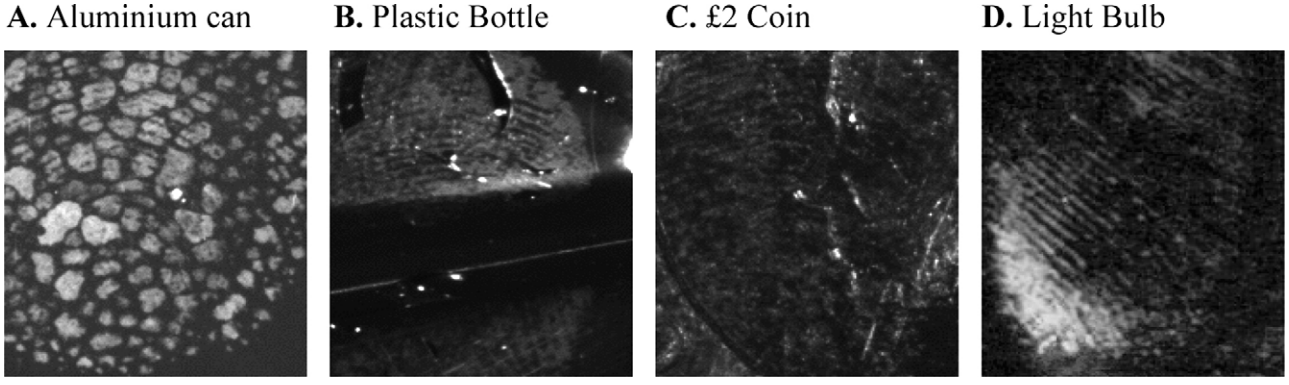

Fig. 1. CNA developed Isomark™ samples.