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Detection of cellular material within handprints

Piyamas Kanokwongnuwut*, K. Paul Kirkbride, Adrian Linacre

College of Science & Engineering, Flinders University, Adelaide, 5042, Australia

A R T I C L E I N F O

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A B S T R A C T

A novel technique for the visualisation of cellular material has been published harnessing an external binding nucleic acid fluorescence dye, Diamond™ dye (DD), in combination with a digital fluorescence microscope. This technique can effectively detect cellular material on an object transferred by touch allowing targeted collection of latent DNA. Previous studies on the visualisation of touch DNA have focussed on transfer from fingertips only.

Here we report on the visualisation of cellular material transferred via twenty different positions over the entire handprint. Three volunteers (a heavy, an intermediate and a light shedder) were asked to press their hands onto a plastic surface with medium pressure for 15 s at undefined time points post-handwashing, creating a complete handprint. DD was applied to the entire area and the presence of cellular material was recorded based on cells within 5 separate frames at each of the 20 positions. All tests were performed in triplicate such that the final dataset contained 1,800 observed frames.

This extensive study allows accurate monitoring of cellular transfer deposited by different parts of the hand. Our study highlights which areas of an individual's hand shed the greatest, or least, amount of cellular material. This simple process can act as a guide for DNA collection from items held within the entire hand, rather than only touched by the fingertips only, such as weapons, knives and steering wheels.

1. Introduction

DNA profiles generated from touched items have been reported since 1997 [1]. Previous studies have reported that different parts of the hands are capable of transferring DNA in different amounts [2,3]. McColl et al. [3] generated DNA profiles from 14 areas of a hand by asking volunteers to touch a glass plate coated with dried saliva, then pressing the hand onto a clean glass plate. Each of 14 parts of the handprint were swabbed, extracted, quantified and subjected to DNA profiling. They found that the amount of transferred buccal cells deposited by fingertips was sufficient for generating an informative profile (10–11 alleles), while the other parts provided less than 4 alleles that matched with the saliva donor.

The fluorescent nucleic acid dye Diamond dye (DD) has been reported to assist in the detection of latent DNA [4–6]. A range of biological samples were observed including saliva [5], hair [6], thumbprint [7,8] and lip-prints [9]. Studies on shedders have concentrated on studying the fingertips only [8], yet it is more likely that items of forensic significance are gripped by the entire hand rather than only the fingertips.

Here we report on the visualisation of cellular material transferred via twenty different positions over the entire hand.

2. Materials and methods

Approval from the Social and Behavioural Research Ethics Committee (reference 8109) at Flinders University was obtained prior to initiating this project.

2.1. Handprint depositions

Three volunteers, a heavy (male), an intermediate (male) and a light (female) shedder, were involved in this study [8]. Crystal clear plastic sheets of A4 size (Hi-Clear, NSW, AUS) were cleaned using a bleach solution of 3% sodium hypochlorite followed by absolute ethanol and irradiation with UV for 15 min prior to DNA deposition. The volunteers were asked to press their hands on the plastic sheet for 15 s, with medium pressure, at an undefined time post handwashing. To collect the entire handprint, thumbs were deposited separately from other parts of the hands.

2.2. DD staining, visualisation and scoring

DD was diluted with 75% ethanol to a working concentration of 20 x for staining cellular material within handprints. Different areas of a

* Corresponding author.
E-mail address: kano0015@flinders.edu.au (P. Kanokwongnuwut).

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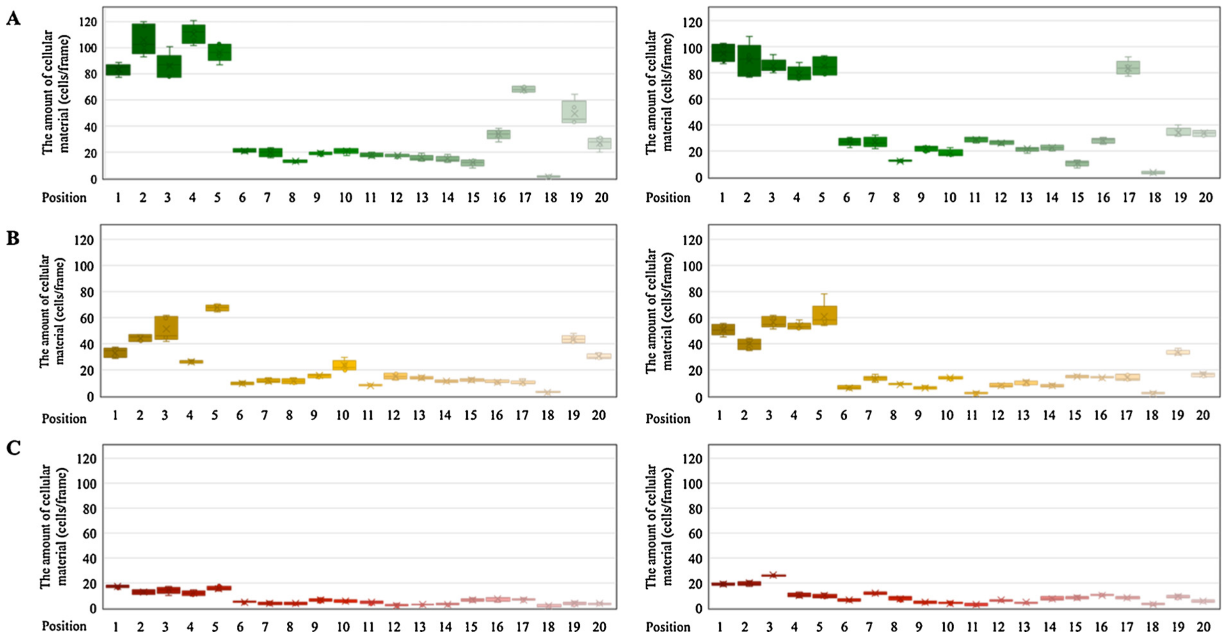

Fig. 1. Cellular material (cells/frame) (x-axis) present in the twenty positions (y-axis) deposited by left (left) and right (right) hands of a heavy (A), an intermediate (B) and a light shedder (C). Data at each position were collected from 15 observed frames at 220 x magnification (n = 15).

handprint were observed separately, 20 in total, comprising: 3 locations of each finger, 3 from the thumb, and 5 from the palm. The stained cellular material was visualised, and the number recorded using a Dino-Lite EDGE AM4115T-GFBW digital microscope and DinoXcope software for MacOS. Cellular material at each of the 20 positions was recorded from five separate frames at 220 x magnification. The average amount of visualised cellular material was scored, using a cell counting program, based on five frames at 220 x magnification for each of the twenty positions. The experiment was performed in triplicate, thus a total of 1,800 frames were observed.

3. Results and discussion

The cell morphology of stained cellular material at each part of a hand were of a similar size and shape. The amount of deposited cellular material correlated with the shedder status of the donor (Fig. 1). The results showed that the distal phalanges (position 1–5) deposited the highest amount of cellular material (Fig. 1). The average amount of stained cellular material presented in the distal phalanges deposited by heavy, intermediate and light shedders deposited was 92, 48 and 16 cells per observed frame respectively. The cellular material deposited by proximal phalanges (position 6–15) was less with a minimum of 2 cells/frame deposited by light shedder, and maximum at 32 cells/frame deposited by heavy shedder (Fig. 1). All three volunteers deposited a few cells via the middle of the palm (position 18), while the deposition of cells via other parts of the palm correlated with the shedder status of volunteers. The amount of cellular material deposited by all areas of the palm in total was less than that deposited by the fingertips.

Our data support previous studies concluding that fingermarks transferred or deposited DNA more than the palm [2,3]. Oleiwi et al. [2] suggested that the thickness of the stratum corneum (SC) varies according to the location on the hand. The SC of fingertips (distal phalange) is thinner than the palm (0.5–2 mm), which may explain some of the observed cellular material deposition variation between regions of the hand. There are several variable factors influencing the transfer of touch DNA such as manner of contact/handing, activity prior touching, manner of handwashing, and age of donor. These factors can be further examined by using DD visualising technique.

Little variation was noted between the amount of cellular material deposited by left and right hands or between the five fingertips of a hand (Fig. 1). No correlation between the amount of cellular material deposited and hand-dominance was observed, which supports the previous studies [8,10].

4. Conclusions

Different parts of hands deposited varying amounts of cellular material. Three volunteers deposited cellular material in different amounts at the distal phalange and palm parts, while a similar amount was deposited by all shedders at the proximal phalanges. The distal phalanges showed the highest amount of transferred cellular material.

Where the type of grip used on touched items is known or can be expected, the trends within this dataset could act as a guide for the targeted DNA collection of deposited latent touch DNA on items to maximum collection and DNA yield. Such a targeted approach can be refined further by visualising cellular material using the DD staining method in order to find the richest cellular deposit within the best sampling region. These approaches could be used to narrow down the area of DNA recovery for a range of items such as shot-guns, knives, steering wheels, or even worn gloves.

Declaration of Competing Interest

None.

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