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Systematic analysis of decadactylar subungueal genetic traces in murder cases

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ABSTRACT

Foreign biological material under the fingernails of a murder victim and/or suspect can be valuable evidence in a criminal investigation. The aim of this study was to evaluate the prevalence of foreign DNA under each fingernail of victims of violent deaths, including fatal struggle or rape cases.

Fingernail swabs or, alternatively clipping nails, were taken from all fingers of both right and left hands from 46 victims (13 females and 33 males) and treated separately. Semi-automated DNA extraction was performed and 21 markers were genotyped.

We detected reliable profiles in all the studied samples ($n = 460$). The majority of results produced a single profile that matched the donor. Foreign DNA was detected in 15/46 victims, 61.5% positive detection in females vs 21.2% in males. A total of 38/390 DNA mixtures were detected in biological material under the fingernails being 19 from right hand (50%) and 19 from left hand (50%). The finger-like distribution was similar in right and left hands where the index, middle and ring fingers showed the 86.8% of the positive results; being these findings in line with the strength and shape of hand's fingers.

The sample treatment optimization increased the possibilities of obtaining biological material from the perpetrator being a powerful tool in a murder investigation. Processing strategy including the pentadactylar analysis of each hand for independent subungueal recovery of informative exogenous genetic material by fingernail clipping or swabbing and the use of optimized extraction and purification protocols might increase the rate of success in identifying criminal felons.

1. Introduction

Exogenous biological material under the fingernails of a murder victim and/or suspect can be valuable evidence in a criminal investigation [1,2]. The evidential value of these samples may be critical if a secondary contributor is found as an isolated profile or even in a DNA mixture. This exogenous profile can be matched with a potential suspect, or through a DNA database search. The importance of these finding increases if it is considered that, even though casual physical activities may leave traces of biological material under the fingernails, the background level of this cellular debris is not usually sufficient to produce detectable DNA mixtures as several studies have been demonstrated [3–5]. Therefore, it is mandatory to follow a careful protocol involving sampling and DNA extraction to optimize results as it is described in the literature [6,7].

The aim of this study was to evaluate the prevalence of foreign DNA under fingernail of victims of violent deaths, including fatal struggle or rape-murder cases. Here, we proposed to analyze each fingernail separately in order to increase the possibility of positive results correlating the victim defense and, in consequence, the reconstruction of the crime.

2. Materials & methods

The routine autopsy protocol indicates obtaining any material that may help identify the attacker. For that purpose, fingernail swabs or, alternatively clipping nails, were taken from all fingers of both right and left hands from 46 victims (13 females and 33 males) and treated separately. Semi-automated DNA extraction was performed using a Maxwell® platform according to the manufacturer's instructions (Promega Corp., Madison, WI, USA). All DNA extracts were quantified by real-time PCR in a Rotor Gene

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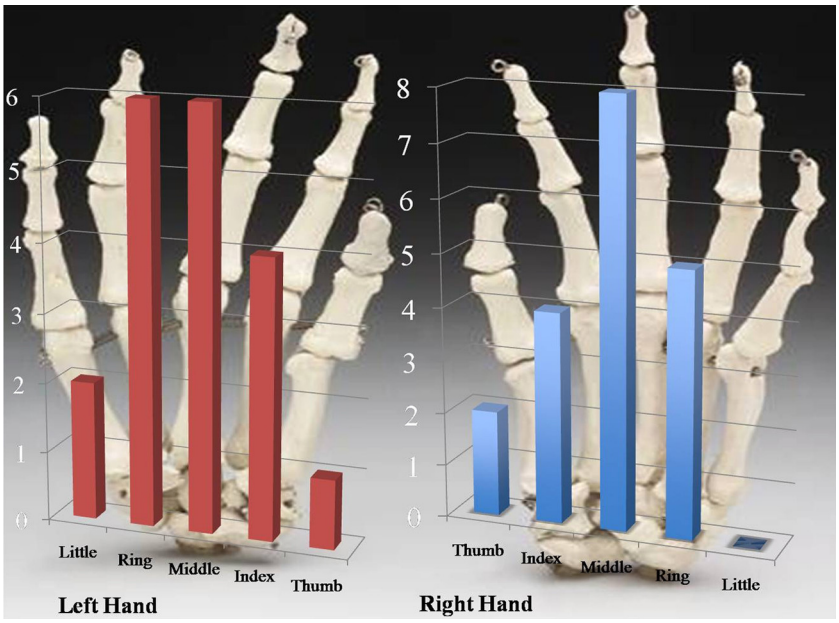

Fig. 1. Finger-like distribution genotyping results in left and right hands.

6000 (Corbett Life Science, Sydney, Australia) using the Plexor HY® kit (Promega Corp., Madison, WI, USA). A set of 21 autosomal short tandem repeats (STRs) and the gender marker Amelogenin, included in the commercial kit PowerPlex21® (Promega Corp., Madison, WI, USA) was used for genotyping.

3. Results

All the studied samples showed reliable profiles ($n = 460$). The majority of results produced a single profile that matched the donor. Exogenous DNA was detected in 15/46 victims, 61.5% positive detection in female vs. 21.2% in males. A total of 38/460 DNA mixtures were observed in biological material under the fingernails being 19 from right hand and 19 from left hand. The finger-like distribution was similar in both hands where the index, middle and ring fingers showed 86.8% of the positive results; being these findings in line with the strength and shape of hand's fingers (Fig. 1).

4. Discussion

The results showed an 8.3% positive detection of exogenous genetic material. While the total ratio of positive detection was lower than the expected, some considerations should be taken into account e.g. type of attack, time span between death and the discovery of the corpse and sampling, preservation conditions of the corpse, among others.

Although, it could be expected to obtain a major percentage of exogenous material detection in right hands because only 10–15% of worldwide population is left-hander, it has to be considered, how the attack occurred and which the victim's defense behavior were. In routine autopsy protocol, fingernail swabs and then clipping the fingernails are taken in rape followed by death and violent struggle cases. It is well known that the sample treatment optimization including sampling, extraction process and the utilization of commercial kits with high discrimination power and increased sensitivity the possibilities of obtaining biological material from the perpetrator. Processing strategy including the penta-dactylar analysis of each hand for independent subungueal recovery of informative exogenous genetic material by fingernail clipping or swabbing could not only increase the rate of success in identifying criminal felons and contribute to the reconstruction of the crime.

5. Conclusion

If a high level DNA mixture is genotyped, especially if the exogenous contributor is the major component, there are high chances that an intimate contact might have been produced between this contributor and the victim's fingernail. The processing strategy described herein has been applied for the last two years and showed to be a suitable tool for obtaining valuable forensic information.

Conflict of interest

The authors report no declarations of interest.

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