



The persistence of DNA under fingernails following submersion in water

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Abstract

In this paper, we discuss the DNA results obtained from the analysis of cellular material located beneath the fingernails of two women in separate cases of homicide. In both cases, the deceased females had been submerged in water, the first in bath water and the second in seawater, for 2 and 3 h, respectively. Mixed DNA profiles were obtained in each case indicating the presence of foreign DNA in these samples. These results indicate the valuable forensic evidence that can be obtained from samples that may be considered unlikely to provide DNA results and the high priority that should be placed on the routine DNA analysis of material from deceased's fingernails, regardless of the scenes that they are found in, including submersion in water.

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1. Introduction

In this paper, we discuss the DNA results obtained from the analysis of cellular material located beneath the fingernails of two women in separate cases of homicide. In these cases, the deceased females had been submerged in water, the first in bath water and the second in seawater, for 2 and 3 h, respectively.

2. Case reports

In the first case, a 33-year-old female was located, fully clothed, submerged in the bath at her home. She had died within the previous 2 h from a number of blows to her head. The

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person who located the deceased had emptied the bath of its water prior to police arrival. The presence of bloodstaining in several rooms of the house, together with disturbed furniture, indicated that there had been a struggle between the victim and the offender. All the bloodstains analysed from the scene were found to be attributable to the deceased. The fingernails of the deceased were clipped at the postmortem examination and were supplied as left and right hand samples; the fingernails from each hand grouped together as one sample. Reference blood samples from the deceased and her family members were also provided for comparison. As no firm suspect had been identified by other means, analysis was sought to determine whether or not foreign DNA could be detected under the deceased's fingernails.

In the second case, a 29-year-old female suicide victim and homicide suspect was located floating in Auckland Harbour. Approximately 3 h earlier, she had been seen falling into the water from a motorway overbridge whilst holding her 11-month-old baby. The deceased had been observed in an altercation with a male colleague about 1 h prior to falling from the bridge. During this altercation, the victim allegedly scratched the male's face. The fingernails of the deceased were clipped at the autopsy and supplied as left and right hand samples. Reference blood samples from the deceased and the male colleague were also supplied for comparison. Analysis was sought to determine whether or not male DNA could be detected under her fingernails as corroborative evidence and to assist in determining whether or not charges should be laid.

3. Materials and methods

Loose material adhering to the fingernail clippings was removed by soaking the nail clippings in 1 ml of sterile distilled water for approximately 30 min. In both cases, the nail clippings were separately submitted as sets of left- and right-hand samples and were extracted as such. The analysis of the reference bloodstains was carried out separately to the analysis of the crime samples.

The loose material adhering to the fingernails was collected by centrifugation of the soakings and DNA was recovered from the cellular material by extraction with 5% chelex [1], 20 µl of proteinase K (10 mg/ml) was added to the 5% chelex prior to incubation at either 55 °C for 20 min or 37 °C overnight. The samples were then boiled for 8 min.

The amount of DNA recovered from the samples was estimated using the ACES™ 2.0⁺ Human DNA Quantitation system supplied by Life Technologies. Between 0.6 and 1 ng of extracted DNA was amplified by the polymerase chain reaction (PCR).

In both cases, the DNA was firstly analysed using the Geneprint™ STR CTT short tandem repeat system supplied by Promega. Amplification was carried out in a total volume of 25 µl using a 480 DNA Thermal Cycler (Perkin Elmer), according to the Promega Manual [2]. CTT amplified products were visualized by electrophoresis on 4% polyacrylamide gels followed by silver staining [3].

For case 1, further DNA analysis was carried out using the SGM (Second Generation Multiplex) STR system supplied by the Forensic Science Service [4,5]. For case 2, additional DNA analysis was carried out using the AMPF/STR® SGM™ Plus (Second Generation Multiplex Plus) STR system supplied by Applied Biosystems [6]. Amplifica-

tion for both of these systems was carried out in a total volume of 50 μ l using a 9700 DNA Thermal Cycler (Perkin Elmer). SGM and SGM Plus amplified products were detected by electrophoresis on an Applied Biosystems 377 Genescanner and analysis using Genescan and Genotyper analysis software [7].

4. Results and discussion

4.1. Case 1

The CTT DNA profile obtained from the left-hand fingernails of the deceased was a mixed DNA profile, as indicated by the presence of extra bands at each of the loci. Part of the DNA profile was consistent with that of the female deceased and the remaining part had likely originated from one male. This male was not the deceased's son or husband, suggesting that this DNA had originated from the offender. These results indicated that this sample was suitable for further analysis using additional STR loci of the SGM system, which was in use in the laboratory at that time.

Analysis of the additional loci of the SGM system confirmed the presence of a mixture of DNA from two individuals. The DNA contributions were in unequal proportions with the female deceased being the minor DNA contributor and an unknown male was the major DNA contributor (Fig. 1).

The male component of the DNA profile was successfully resolved and submitted for comparison to the New Zealand National DNA database [8]. This database contains DNA profiles from individuals who have either been convicted of an indictable offence or who have voluntarily supplied a blood sample. A 'hit' was obtained to a male individual on the National DNA database and a confirmatory blood sample, as required under the New

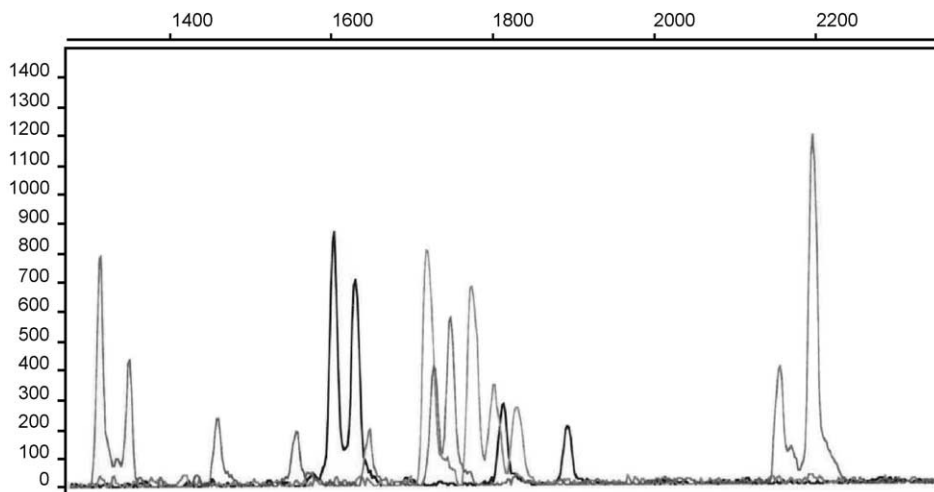


Fig. 1. SGM results for the left hand fingernail clippings from the deceased in Case 1.

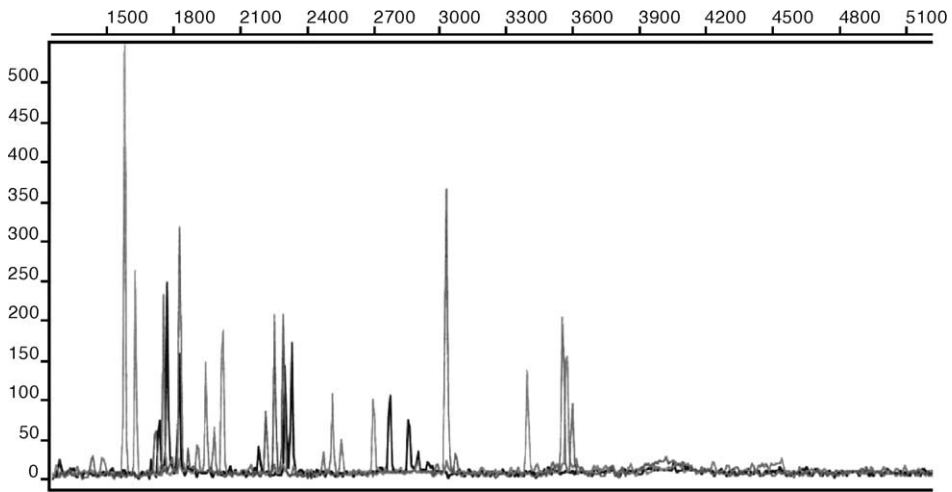


Fig. 2. SGM Plus results for the fingernail clippings from the deceased in Case 2.

Zealand Criminal Investigations (Blood Samples) Act 1995, was obtained from this individual.

Statistical assessment of the mixed DNA profile [9] resulted in a likelihood ratio of 100 million. Prior to the DNA evidence the individual had been regarded as one of a number of suspects for this crime. Following a High Court Trial, the accused was convicted of murder and sentenced to life imprisonment.

4.2. Case 2

The CTT DNA profile obtained from the left-hand fingernails of the deceased was also a mixed DNA profile as indicated by the presence of extra bands at each of the STR loci. The Amelogenin locus also indicated that male DNA was present in this sample.

Additional DNA analysis using the SGM Plus system confirmed the presence of two sources of DNA, a male and a female (Fig. 2). The major component of the DNA profile originated from a male and corresponded with that of the deceased's male colleague. The minor DNA profile corresponded with that of the deceased. The DNA evidence corroborated the accounts of the incident as given by the male colleague and other witnesses. Consequently, no charges were laid and the case was heard in the Coroner's Court.

5. Discussion

These two cases illustrate the sensitivity of current DNA technology and the value of undertaking DNA analysis of material beneath fingernails, regardless of individuals' hands being submerged in water. These findings further support the findings of Lederer et al.

[10], who obtained a victim's DNA profile from under a suspect's fingernails, despite multiple washings and a 2-day time delay prior to sampling.

It has been suggested that fingernail debris has minimal evidential value and should not be routinely submitted for DNA analysis in forensic casework [11,12]. The results of DNA analysis of the fingernail debris in these two cases indicate the value of routinely collecting and analysing fingernail debris for those cases where an individual has likely been scratched.

Given that in cases of homicide the actions of the deceased during the incident are usually not fully known we recommend the mandatory collection of fingernails from all deceased, regardless of the scenes that they are found in, including submersion in water.

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