A75 Trace DNA From Fingernails: Increasing the Success Rate of Widely Collected Forensic Evidence

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After attending this presentation, attendees will appreciate the need for standardization in collecting and processing fingernail evidence and will be informed about best practices for recovering foreign DNA from fingernails and which DNA analysis methods are most successful for producing a DNA profile.

This presentation will impact the forensic science community by disseminating an optimized method of collecting and processing fingernail evidence which currently does not exist. The research has the potential to have a substantial impact on the way forensic pathologists, forensic nurses, and forensic biologists conduct their work. The experiments were specifically designed to quickly and directly benefit practitioners so they will know how to best collect and process nail evidence.

Direct contact between an assailant and victim occurs during sexual assault and many other violent acts. As the victim attempts self defense, biological material from the assailant may be left, particularly under fingernails. Forensic nurses, emergency personnel, and pathologists often collect fingernails or material beneath fingernails from surviving or deceased assault victims for DNA testing. Unfortunately, very little is known about the utility of such collections, including if the existing methods for obtaining and testing fingernail/DNA evidence are optimal for producing probative evidence. Procedures for fingernail evidence collection and examination have never been standardized or optimized, nor has their subsequent genetic testing. In different jurisdictions nails can be clipped, scraped, swabbed, or simply not collected at all. A new set of clippers might be used for each hand, for each case, or the same set used for all cases. Rarely are nails treated individually, but instead are collected and processed for the right and left hand, raising the possibility of cross contamination or dilution of an assailant's DNA if it resides under only
one nail.

Given the thousands of nail samples collected following sexual assault or upon autopsy each day in the United States, a surprisingly small amount of actual research has been conducted on nail evidence. In consultation with several forensic practitioners, the research to be presented was designed to address these questions in an objective and statistically reliable manner. First, the general level of foreign DNA found under nails was examined. Next, volunteers scratched one-another's forearm under a constant level of pressure, using the middle three fingers of each hand. A buccal swab was also provided. Multiple methods for collecting nail evidence were tested, including swabbing the underside of a nail with a wet swab moistened with an SDS solution, a wet swab followed by dry swab, scraping beneath the nail, and clipping and analyzing an entire nail. Likewise, the utility of processing nails individually or combining all nails from a hand together was examined. DNAs were quantified from each collection method and various DNA analysis procedures widely used in crime laboratories (STRs, miniSTRs, YSTRs) were evaluated using commercially available kits. Finally, experiments were conducted to examine if the results could be enhanced by increasing the DNA injection time (30 sec), injection voltage (3 kV), post-PCR purification, and increasing the volume of amplified DNA loaded for electrophoresis.

The recovery of exogenous DNA from under the fingernails of average individuals was uncommon using standard collection techniques. In general, a major profile matching the nail donor was seen, and any alleles foreign to the nail were weak and small in number (one or two loci). Likewise, standard STR analysis of post-scratching nail debris produced few alleles from the person being scratched, and occasionally produced a complete profile of the scratcher. In contrast, YSTR analysis tended to lead to more callable alleles from the person being scratched (when females scratched males, as would be most common in a forensic situation). Increased DNA injection time (30 sec), injection voltage (3 kV), or post-PCR purification resulted in an approximate doubling of peak heights, along with some new callable alleles, and in some instances, a complete YSTR profile was obtained. Combining the increased injection time and voltage raised peak heights even more. In contrast, loading a higher volume of amplified DNA did not appear to increase peak heights nor increase the number of callable alleles.

The fact that foreign DNA is relatively uncommon under fingernails accents the significance of those instances wherein a foreign DNA profile is obtained from fingernail evidence. In this regard, utilizing YSTRs when a female is assaulted by a male may be preferable as more data may be obtained than when utilizing standard STRs. Finally, the ability to generate callable alleles can be enhanced by post-PCR purification or by modifying the injection parameters of the genetic analyzer.

DNA, Fingernail, Sexual Assault

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