Emerging Forensic DNA Technologies and Ethical Concerns

Riley McCaffrey, Lydia Stemmler, Nina Saviozzi and Wendy Gruhl, MS
Loyola University Chicago, Forensic Science Program, 1068 W. Sheridan Rd., Chicago, IL 60660
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Introduction

- Traditional Forensic DNA Analysis (STR analysis) is used to compare reference standards to evidence samples from crimes. If no reference standards are available, evidence samples may be entered into a database (CODIS) to provide an investigative lead.

- Forensic DNA Phenotyping (FDP) may be used to generate an investigative lead if traditional methods fail to provide one. This type of analysis uses differences in DNA sequences to predict physical characteristics of the donor, such as eye, hair, and skin color. Using this type of analysis on an evidence sample can provide a "digital sketch" of a suspect.

- Forensic Genetic Genealogy (FGG) is an alternative method to generate investigate leads. This type of analysis is done by private laboratories. Evidence samples analyzed with this technology are compared to public and/or private databases to see if any family members of the donor can be found.

- FDP and FGG are new technologies applied to criminal investigations, and both have ethical, privacy, and legal implications.

How it works

<table>
<thead>
<tr>
<th>STR Analysis</th>
<th>SNP Analysis</th>
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<tr>
<td>Short Tandem Repeats</td>
<td>Single Nucleotide Polymorphism</td>
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<td>Based on a repeating length of nucleotides</td>
<td>Based on a single point mutation of one nucleotide</td>
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<td>Used in traditional casework analysis to match DNA profiles</td>
<td>Used in genetic genealogy and phenotyping</td>
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<td>Only 20 loci, or points on the genome, are analyzed in casework</td>
<td>Entire genome is analyzed to find hundreds of thousands of SNPs to generate a profile</td>
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<td>Analysis is focused on non-coding portions of gene</td>
<td>Analysis is not restricted to non-coding portions of gene</td>
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<td>Can be used to analyze degraded samples or mixtures</td>
<td>Need single source high quality DNA</td>
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Table 1: Comparison of STR & SNP Analysis

Traditional DNA analysis examines around 20 loci in non-coding regions - with no phenotype (outward characteristic). SNP analysis encompasses the whole genome; some SNP loci are related to phenotypes while others are not.

Ethical Concerns & Misuse in Criminal Investigations

- FDP: sketches provided are generic (many factors not related to SNPs affect how people age/have); certain phenotypes are more accurately predicted e.g., eyes that are blue or brown are more accurately predicted than those that are neither or somewhere in between; potential for generic sketches to increase racial profiling in police investigations.

- FGG: Inherent racial bias in genetic databases as a result of skewed demographic participation towards European / Caucasian populations; opaque privacy policies; potential for misuse - FGG & FDP in Casework

Event occurs where evidence needs to be collected

Evidence is collected by Law Enforcement Agencies (LEA) and sent to the lab for testing

If there is no match within CODIS, LEA requests further testing to be completed

Traditional STR analysis is completed, and the results are uploaded into CODIS

There is an association in CODIS. Results are reported back to LEA.

FGP, which also uses SNP analysis, is completed. A probable image of what the person may look like is created.

FDP, using SNP analysis is done, and a complete DNA profile is uploaded to database and compared to other profiles.

The profile is upload to database and compared to other profiles

FGG: Relatedness between individuals is calculated by examining the distance between SNPs due to recombination events. The more closely related individuals are, the longer the stretches of shared DNA segments will be. Length and number of shared sequences can approximate relatedness up to fourth or fifth cousins.

DNA profiles are uploaded to public or private databases where they are compared.

*Like any investigative tool, none of these techniques are guaranteed to provide an investigable lead*.

References