

Y-STR Profiling is a Unique and Valuable Tool in Forensic Investigation

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ARTICLE INFO

Article Type:
Case Presentation

Article History:
Received: 5 Nov 2012
Revised: 28 Nov 2012
Accepted: 29 Nov 2012

Keywords:
Forensic Investigation
Identification
Paternity
Y-STR Profiling

ABSTRACT

Background: Y-STR profiling is an important branch of DNA Fingerprinting that links male individuals from the same paternal lineage. When this technology arose, it increases the types of forensic applications which can be solved via DNA Profiling.

Case Presentation: In this report, three cases have been discussed through presenting their scenario, clarifying the circumstances in which DNA samples were analysed, and interpreting the results in which Y-STR profiling plays the main role in solving the clue of those challenging cases creating a unique and valuable tool in forensic investigations.

Conclusion: Y-STR Profiling can be employed as an investigative tool presenting solutions for solving several mysterious forensic cases.

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► *Implication for health policy/practice/research/medical education:*
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► *Please cite this paper as:* Refaat AM. Y-STR Profiling is a Unique and Valuable Tool in Forensic Investigation. *International Journal of Medical Toxicology and Forensic Medicine*. 2012; 2(4):143-147.

1. Introduction:

The Y-chromosome is paternally-inherited (from father to son). It is passed from father to son as an exact copy with the exception of small mutations/changes in the DNA. Since these changes accumulate over the generations, father and son have the most similar Y chromosome DNA sequences as compared to more distantly related males (1). The polymorphisms of Y-chromosomal short tandem repeat (Y-STR) loci are a powerful tool for identification and confirmation of shared paternity and the relatedness of half-brothers or grandfather and grandson (2). The high geographic specificity of many

non-recombining portions of the Y chromosome (NRY) haplogroups provides forensic scientists with clues to the source of the male genetic material left at a crime scene. The forensic utility of Y-STRs results from their high levels of polymorphism in human populations, their small size in base pairs (~100-400 bp), and the ability to type multiple Y-STRs in a single PCR reaction (3). The aim of this report is to show the significance and uniqueness of the utilization of Y-STR profiling in certain types of murder cases as well as paternity cases. This was achieved through the presentation of three cases, interpreting the results of Y-STR typing in each of them in order to evaluate the use of Y-STR profiling as a unique investigative tool helps in solving crimes,

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and give solutions in certain types of cases where traditional autosomal STR typing cannot solve the problem.

2. Case Presentation:

Case 1

A woman has been raped and killed, and then the offender buried her corpse inside the sand in the desert. After the recovery of the corpse, her nails were examined and they were found to contain minute dried blood stains. Two weeks later, criminal inquiry resulted in restricting the suspicion to two persons who suspected to commit the crime.

DNA Analysis

Y-STR profiling was analysed for whole blood samples taken from the two suspects, in comparison with the sample of nail scrubbings containing blood recovered from the corpse, and the results are shown in figures; 1a, 1b, and 1c.

Genotyper plot of each of the three figures; 1a, 1b, and 1c include the following panels:

1. PowerPlex-Y Allelic Ladder.
2. Nail scrubbings containing blood from the corpse.
3. 1st Suspect.
4. 2nd Suspect.

Upon comparison of the full Y-STR

profile generated from the mixed biological sample recovered from the victim (panel 2), with the two Y-STR profiles of the two suspected persons (panels 3 & 4 respectively), the decision in this case was the conviction of the 2nd Suspect (panel 4) with committing the crime and the exoneration of the 1st Suspect (panel 3).

Case 2

One individual has reported to the police that the daughter of his brother does not tolerate upon knocking on the door of her apartment which lies inside the same flat where he resides in. Upon entering the apartment, the corpse of the victim was seen lying on the floor and she was found slaughtered in her bedroom. A blood sample was taken from the corpse of the victim, and several blood stain samples were recovered from different parts of the apartment. Criminal inquiry suspected that the uncle of the victim who reported of her absence is the offender. A blood sample was taken from him and compared with the blood stain samples recovered from the apartment.

DNA Analysis

Autosomal STR profiling was carried on all blood stain samples recovered from the

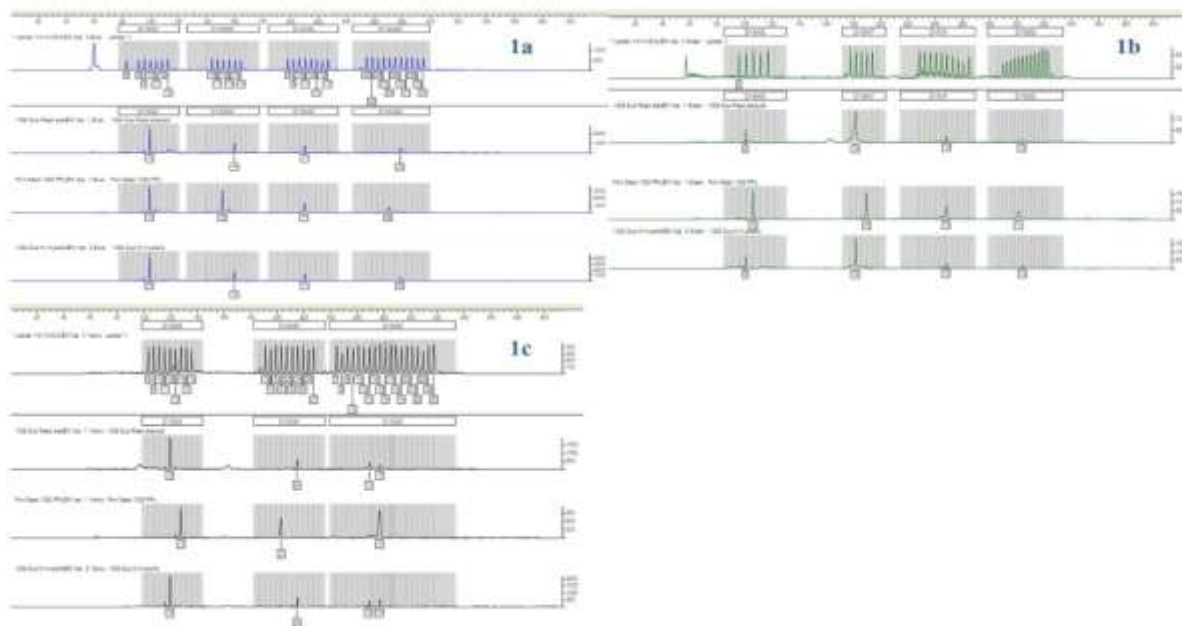


Fig. 1. a: Case no1; Y-STR Profiling1. b: Case no1; Y-STR Profiling2. c: Case no1; Y-STR Profiling3.

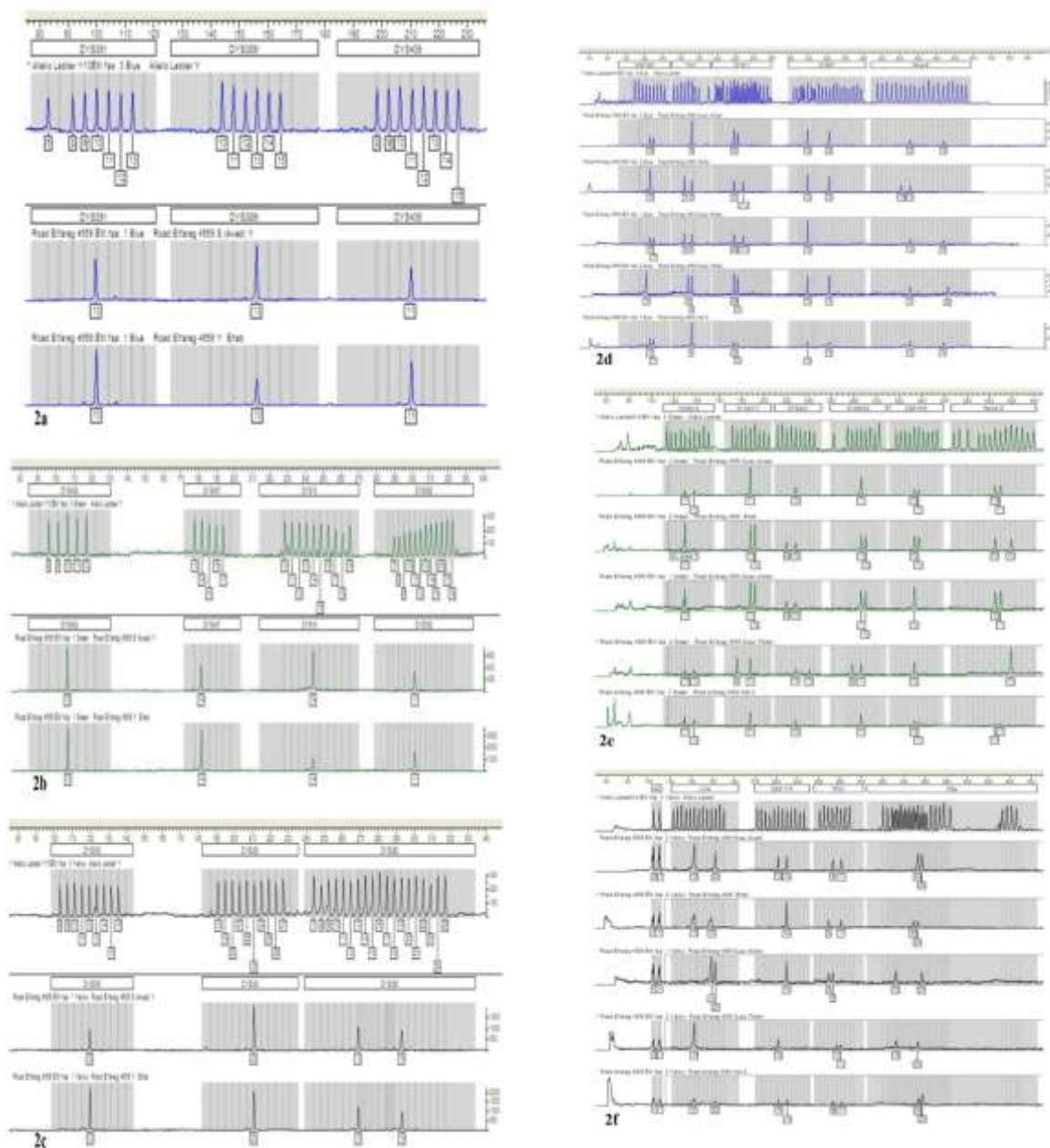


Fig. 2. a: Case no2; Y-STR Profiling 1. b: Case no2; Y-STR Profiling 2. c: Case no2; Y-STR Profiling 3. d: Case no2; Autosomal STR Profiling 1. e: Case no2; Autosomal STR Profiling 2. f: Case no2; Autosomal STR Profiling 3.

crime scene together with the blood sample taken from the uncle of the victim who is suspected to commit the crime. The results showed that there is only one blood stain sample from the crime scene which is attributed to an unknown source and it was for a male person who was believed to be the true offender, while other blood stain samples were attributed to the victim. On the other side, Autosomal STR profiling exonerates the uncle of the victim from being the offender.

The suggestion was performing Y chromosome analysis for the sample of unknown blood and that of the victim's uncle, and results are shown in figures; 2a, 2b, and 2c.

Genotyper plot of each of the three figures; 2a, 2b, and 2c include the following panels:

1. PowerPlex-Y Allelic Ladder.
2. Unknown blood stain sample.
3. Victim's uncle.

According to the results of Y-STR Profiling which showed concordance between the Y-STR Profile of the unknown blood stain sample (panel 2) and the Y-STR Profile of the sample of the victim's uncle (panel 3), the unknown blood stain sample was compared to four blood samples taken from all the four male members in the family of the victim's uncle via autosomal STR profiling, and the results are shown in figures; 2d, 2e, and 2f. Genotyper plot of each of the three figures; 2d, 2e, and 2f include the following panels:

1. PowerPlex 16 Allelic Ladder.
2. Unknown blood stain sample.
3. 1st Suspect.
4. 2nd Suspect.
5. 3rd Suspect.
6. 4th Suspect.

Upon comparison of the autosomal STR profile of the unknown blood stain sample (panel 2) with the autosomal STR profiles of the four suspected male members of the victim's family (panels 3, 4, 5, and 6 respectively), the decision in this case was the conviction of the 4th Suspect (panel 6) with committing the crime and the exoneration of the other three Suspects (panels 3, 4, and 5).

Case 3

In a trial; a married man accused his wife of mistakenly ascribing her new born to him. He proved that he was abroad when pregnancy occurred. The court transforms the case to the DNA profiling laboratory to investigate through DNA analysis. Three blood samples were taken from the mother, the new born, and the husband to compare and decide whether the husband is the biological father of the child or not.

DNA Analysis

Autosomal STR profiling was done for the three blood samples mentioned above which showed that paternal alleles in the DNA profile of the child are not present in the husband's DNA profile which proved that the husband is not the biological father of the child.

The suggestion was performing Y chromosome analysis for both samples of

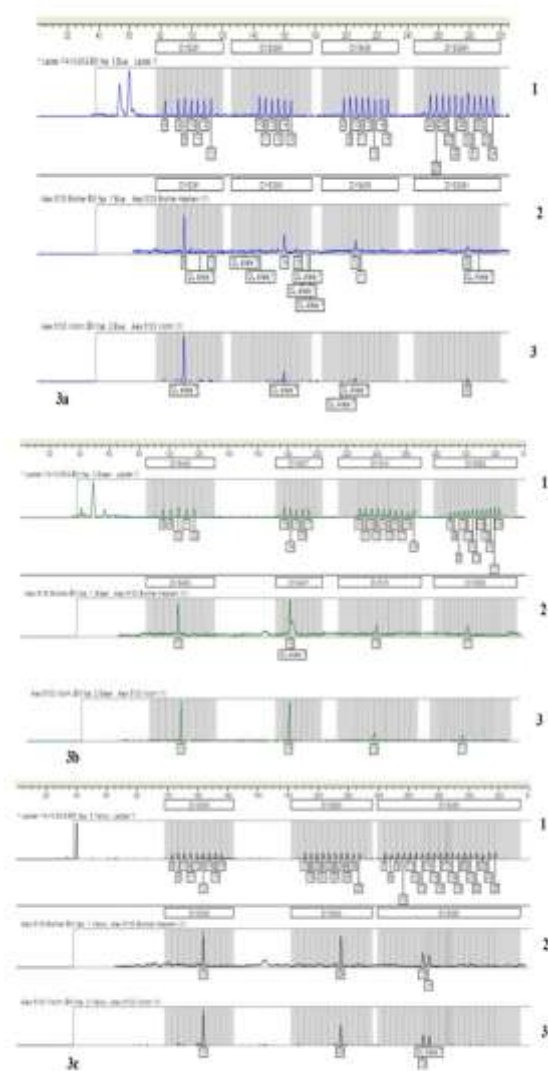


Fig. 3. a: Case no3; Y-STR Profiling 1. b: Case no3; Y-STR Profiling 2. c: Case no3; Y-STR Profiling 3.

the child and the husband, and results are shown in figures; 3a, 3b, and 3c.

Genotyper plot of each of the three figures; 3a, 3b, and 3c include the following panels:

1. PowerPlex-Y Allelic Ladder.
2. New born child.
3. Husband

Upon comparison of the Y-STR profile of the child with the Y-STR profile of the husband, there was a concordance between both Y-STR profiles, putting into consideration that the husband's elder brother is the only adult male member in the husband's family, which indicates that

the husband's elder brother is the true biological father of the child.

3. Discussion:

In case 1; Despite of the presence of a mixed sample containing the DNA of the victim present in her nails, and the DNA of the offender present inside his WBCs, the mixed sample of nail scrubbings containing blood was shown to contain an obvious pure pattern of male DNA.

In this case, Y-STR profiling has played a key role in the identification of the true offender who committed the crime at the time where autosomal STR profiling cannot solve the problem due to the presence of mixed DNA profiles.

In case 2; the victim's uncle who was the only suspect according to the criminal inquiries, was excluded from being the proprietor of the blood stain recovered from the crime scene which was believed to be attributed to the offender.

In this case, Y-STR Profiling comes as an investigative tool to search about the criminal whose blood was left in the crime scene, through comparing the Y-STR profile of the unknown blood stain with the Y-STR profile of the victim's uncle and when there is a concordance between both of them, this directs the investigations towards searching on the true offender in between the male members of the victim's family, and finally the true offender was assessed via autosomal STR profiling.

In case 3; it is a disputed paternity case in which the husband succeeded to prove that he is not the biological father of the child via autosomal STR profiling. On the other hand, the court hasn't the capability to mention who is the true father of the child resulting in denying the child from all his legal rights towards his father.

In this case, Y-STR profiling comes as an investigative tool which helps to find the true biological father of the child. This was done through comparing the Y-STR profile of the new born with the Y-STR profile of the husband guessing that the true father may be one of the male members of the father's family, and when there is a concordance between both Y-STR profiles, this directs the investigations towards the fact that the true father is one of the husband's family. And since the husband's elder brother is the only adult male member in the husband's family, this proves that the husband's elder brother is the true biological father of the child.

4. Conclusion:

Y-STR Profiling can be very useful as an investigative tool prior to decision, which in many Forensic cases presents valuable facts to investigators that can solve the clue of several mysterious cases. It is recommended to perform Y-STR Profiling in certain cases including; mixed biological samples, disputed paternity, and identity cases in which suspicion may be directed towards kindred.

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