

Issues with DNA Fingerprinting in Forensic Lab: A Review

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Abstract

Successful interpretation of DNA is influenced by the value of crime scene evidence and the availability of suitable reference samples. Errors and uncertain results are the hidden sides of DNA fingerprinting. Efforts are underway to improve the results in this field. The DNA is chosen here because it is extensively practiced and act as a DNA ID card whereas DNA fingerprinting is an optimistic technique for forensic scientists. The target of this paper is to develop a professional and scientific view on the issues with DNA profiling in a forensic lab. In this paper a short outlook about DNA profiling objectives and techniques discussed but the main aim of this paper is issued about DNA fingerprinting. It is an interesting technique to investigate someone because DNA fingerprinting also identifies the non-coding regions of the genome which makes discrimination among individuals of a species.

Keywords: DNA profiling; RFLP; VNTR's; DNA typing; PCR; Genomic fingerprinting

Abbreviation: DNA (Deoxyribose nucleic acid), PCR (Polymerase chain reaction), VNTR's (Variable number tandem repeats), RFLP (Restriction fragment length polymorphism), COIDS (Combined index DNA system).

Introduction

An exclusive type of fingerprinting is known as "DNA fingerprinting", it rests the same in all body parts and there is no method to modify it. DNA of every person is 99.9% identical but there is a 0.1% differences among individuals. The DNA sequence is just like fingerprinting. There are so many bases which are time-consuming but now scientist introduced some techniques which quicken the identification process. This (DNA fingerprinting) technique is like a bar-code of an individual's DNA [1]. DNA is found in every cell of an individual. DNA is tightly bound with histone protein, it is present in each chromosome [2]. It had a tremendous impact in forensic genetics. Forensic science is an intersection between crime and

science. Its help to police inspect all the serious case and also an important tool for court outcomes. The progress of forensic science services clearly depends on police investigators understanding the scope, importance, and limitation of forensic science. It has perpetuated challenges for individual's and the court also accept as pivot evidence [3]. DNA typing played a supportive role and was the last resort when other methodologies failed. It provides an impressive approach in victim identification both at small scale and large scale disaster. It became a gold standard for victim identification. The U.S National Research Council of the National Laboratories issued a major report on forensic science in February 2009 "With the

exception of nuclear DNA analysis, no forensic method thoroughly shown to have the capacity to consistently, and with a high degree of certainty, demonstrate a connection between evidence and a specific individual or source". VNTR's are variable number tandem repeats. These are noncoding regions and don't have any unravel information about the genome. Genetic material is absent in these regions. So these regions are helpful in identifying a person.

Potential samples for DNA investigation

Samples for typing of DNA can get from any biopsy tissue of an individual, blood, saliva, vaginal fluid, semen, items of personal use such as razor, toothpick, bottles, cans or glass, used cigarette butts, bite marks, bone teeth, hair, and clothes or any type of biological remains can be used for profiling. Urine can also be used to extract the DNA from epithelial cells which release from digestive tract during urination but in recent studies it has been shown that in healthy persons epithelial cells can't be discharged in urination. In case of blood white blood cells are under observation for attaining DNA because these are nucleated cells. Although red blood cells also contain nucleus but at maturation their nucleus disappears. Hair follicles bearing cells so during investigation hairs act as evidence. Our skin has upper layer of cells. This upper layer consists of keratinized cells which are dead in nature and shed off quickly from our body and act as evidence at crime scene [4]

Background

This technique was discovered by Sir Alec Jeffery in 1984 at Leicester University in the UK. He was a geneticist and work on genes. He was focusing on the methods to determine the paternity and colonization disputes by signifying the genetic links between persons. The first person who was arrested by DNA investigation Colin Pitchfork. He raped and then murdered to two girls Lynda and Dawn in 1983 and 1986 respectively. Semen was collected by investigators and analyzed in a forensic lab to clear the whole story. When DNA pieces of evidence prove that Colin was a criminal then he confessed his crime and arrested [5]. The era of the 1990s is the golden period of new technologies and discoveries. This era proves valuable for forensic scientists. This technology used to check the whether the sera of the same person or not [6]

Use of DNA finger-printing

It is used to categorize inherited diseases, identification of victim (by comparing profiles of a victim with reference samples), usage for paternity test, genetic profiling of an individual in a species, to

check dissimilarities among individuals of different species, to find out the evolutionary relationship among closely related species, this technique is used in breeding programs, for tracking threatened species, used for sex determination, for conservation of biodiversity [7].

Goals

There are some objectives of this review which indicate the importance of this paper such as to avoid negligence of handlers, with the help of DNA evidence give punishment to a guilty person instead of innocent one, aim to pay full attention during a research work, another purpose is try to eliminate the wrong perception of people about DNA finger-printing, taking a good care during DNA evidence analyzing, try to develop understanding among persons, spread awareness to make a connection between people and analyst and to improve the methodological techniques comprising in DNA analyzing process.

Techniques

Two types of techniques are used in DNA typing, these are PCR (polymerase chain reaction) based and non-PCR based. Non-PCR based techniques are traditional techniques, time taking, slow processing, initiate good results and required a large amount of DNA sample for analysis. Whereas PCR based techniques are rapid in their nature and a small amount of DNA sample required for analysis but there is a chance of contamination during PCR amplification. Non-PCR based technique is RFLP (restriction fragment length polymorphism). This technique firstly used by scientist in the lab during analyzing DNA. On the other hand, STRs (short tandem repeats), microsatellites, and mini-satellite are PCR based techniques. All these procedures identify VNTR's (variable number of tandem repeats) regions in the genome. There are so many other techniques for analyzing DNA fingerprinting but these do not give accurate results. The Y-chromosome technique is an advanced technique but it is used in highly efficient laboratories. If the DNA samples are timeworn such as hair, tooth, and bone then it lacks DNA in the nucleus or improper DNA is present which is difficult to evaluate. So RFLP and STR technique were not applicable because they require nucleated DNA. In this case, mitochondrial DNA is used for genetic interpretation. Nanotechnology, DNA microarray analysis and multiplex PCR technology are advance techniques in DNA profiling but these techniques face some challenges in profiling of DNA [8]. Electrophoresis gel, southern blotting and hybridization also used to transcribes the results. PCR technology also give rise to

errors such as stature formation, slippage of primer and false peaks are shown on the graph [9]. Different types of DNA techniques are used in collection of DNA sample name as Electrostatic Detection Apparatus (ESDA), dry swabbing and substrate cutting. ESDA and dry swabbing are non-destructive whereas substrate cutting is a destructive technique [10]. Another technique which is famous as “Real Time PCR”, it is used to determine the gender from a degrade DNA sample SRY PCR is also a sex determine technique [11]

Critical challenges

Although DNA fingerprinting is an effective and powerful tool to tackle mysterious cases such as murder and rape there is a number of challenges with DNA profiling in forensic science which are not easy resolve and make the evidence unreliable. It has been unblemished that forensic laboratories affected by various problems [12]. These issues lost the trust of people on genetic shreds of evidence. On the basis of these issues, the victim can't be identified clearly and make a sense of depression in complainant. Issues which are involved in genetic typing are degradation of sample, mishandling problems, errors in hybridization and probing process, privacy issues, negligence, un-experienced person, default with database, intermixing and fragmentation of samples, incorrect data entry, storage issues, miss-matches, identical twins, DNA evidences easily planted at a crime scene [13]. Corruption, tampering with evidence, misconception during labeling sample. DNA also degrade with prolonging contact to sunlight, humidity, and heat. Instrumental errors also lead to the unreliable results. A verity of DNA polymerase enzymes are used such as Bio-X and Taq. Polymerase etc. But each enzyme having sensitive limitation [14].

Privacy issues

DNA profiling is contrary to public belief. One key disadvantage of DNA analysis is the potential for invasion of individual privacy. Because a person's DNA divulges a lot of information about his physical state, it is sensitive information that must be carefully guarded. Information about an individual ethnic background and percentage could become a cause for discrimination. Law enforcement agencies and federal government pressure the companies to share your DNA. People are feared to giving their sample of DNA to DNA data-bank of police or any other field such as forensic laboratory because they don't want to give about their complete information to anyone due to privacy issue [2]. Sensitive genetic information of a person is exposed to another individual and it is against human rights. Even personal information such as heredity disease and race also revealed through the DNA analysis [15].

Lack of expertise

Many commercial agencies have been involved during DNA analysis. These fields required professionals to sort out difficult cases. Sometimes an expert witness is so-called experts or they are not expert in their field. If you cannot clarify your evidence to someone that is not from the field (like a judge) and you need a lot of technical justifications to report it, then the result is not good. Should leave it on your desk not to take it home. This is a very common sense tactic to a problem. Anyhow DNA finger-printing evidences depends upon quality of specimen. Laboratories have diverse protocols and in some cases, different results have been obtained when the same samples acquiescing to different labs. Use of different technologies shows a breakthrough in the identification of criminals [16]

Low template DNA

Cell free DNA is dubbed as template DNA. When the amount of DNA is less than 200 pico-gram then it's known as low template DNA. It leads to higher chances of contamination. Low template DNA are coming to court with inadequate capabilities for sound interpretation. There is a danger with limited DNA but experts know how to handle and manage them. This problem can be tackle with the help of PCR technology through which amplification can be done of tiny amount of DNA converted into many copies of DNA to achieve its profiling. But chemicals which are used in drawing out of DNA inhibit the fruitful DNA amplification [17]. Unfortunately, proper management is not a universal practice. If the sample is in minute amount then it became probabilistic to cope with significant results. There is greater detection sensitivity when the sample is more complex DNA mixtures, low template DNA or touch evidence. Use of difficult threshold to avoid “skating on ice”. Low template DNA also give rise to low quality of DNA [18]

Touch-DNA

More touch DNA shreds of evidence submitted a more poor quality interpretation of results formed. Touch DNA contaminates pieces of evidence. Nylon or cotton swab are used to collect the DNA samples from criminal site. Nylon swabs engendered high quality of DNA as compared to relative florescence units of peak heights [19]. It defined as the transmission of DNA through skin cells when anything either touched or pick up. Touch DNA sample gained the attention of forensic scientists. It is extremely instructive and complete collection of evidence is ensured by DD (Diamond Dye) chemical, it is cost effective [4]. Sometimes mixture of genome takes place which

give rise to unreliable results due to contamination. Co-incident matches or sometimes genetic identical persons such as “chimeras” excluded incorrect consequences and shown the major drawback of this DNA typing technology [20].

Ecological impacts

Humidity, temperature, bacterial contamination, moisture conditions, UV (ultraviolet)-rays, direct sunlight and dampness also shown a significant impact in the perception of DNA-typing. Unfavorable conditions such as damp environment cause oxidative damage and hydrolytic cleavage bond occurs. Under the influence of these types of environmental factors nicking of the whole DNA take place [21].

Fake DNA marks

Sometimes fake or synthetic DNA also troublesome for wrong interpretations. These fake DNA's causes incorrect perceptions and act as a limitation to believe in DNA evidence as truthfulness. In a DNA fraud case, a Canadian physician planted fake DNA evidence in his own body: John Schneeberger raped one of his patient in 1992 and at the crime, scene semen left as a DNA evidence. Police investigated the case and matched the Schneeberger blood's with crime scene semen, results drew totally different never showing a match. In another case, the Phantom of Heilbronn, police spy identified DNA samples from the same woman on different crime scenes in Austria, Germany, and France among them robberies, burglaries, and murders. Only after the DNA of the “woman” exactly matched the DNA sampled from the burned body of a male asylum seeker in France did detectives start to have serious doubts about the DNA evidence. Laterally it was found that DNA traces were already present on the cotton swabs used to collect the samples at the crime scene, and the swab had all been manufactured at the factory of Austria. The company's product specification said that the swabs were guaranteed to be sterile but not DNA free. Nucleix is an Israeli company introduced a technique to differentiate between fake DNA and the original sample.

Instrumental troubles

Biological contamination of tools, instruments are too old and further usage which give authentic results can't be possible, breakage of instrument, software and computational problems, mishandling of instruments and biased function of PCR which creates stutter formation false peaks and adenylation. These are few problems which give unreliable results in DNA finger-printing [22]

Hacking

DNA database is a collection of DNA profiles of previous cases culprits, offenders and as well as the witness of the crime scene. The major DNA databank is present in United State known as COIDS (Combined Index DNA System). DNA Database of forensic science also contains DNA pieces of evidence of persons who have been involved in a crime (victim, offender and who are affected by crime) as well as related to a crime such suspect [23]. There is also a database for missing person and human remains. Having DNA in databank is no suspicion useful and many cold cases are resolved with its help. The U.S.A is not the only country which has DNA database, other countries such as Britain from where this incredible technique is originated also keep DNA database, but it's doesn't mean it totally dependent on this technique to cracking out all the crimes. While all the states of the USA do not require the DNA database. GATTACA is a science fiction movie in which fitness's determined by genes. Ethan Hawke was a boy which become a cosmonaut but he had a heart problem from his childhood so he had not some facilities such as insurance, he wanted to become a superhuman and trying to search perfect genetic engineer to change himself even his eyelashes and skin cells because he already knows that a person's profile made with even a small strand of hair. He is careful about himself because any bit of him will tell the people what he actually is. This science fiction movie tells us that having a risk of DNA in a databank. Peoples afraid by hackers who exploit computer systems and gain someone's personal information easily and as a result get profit through black-mailing. Any corruption and dishonesty such as tempering or hacking of data experts can ruin an individual's life by DNA finger-printing. COIDS of US is shared by few other countries Databank is the heart of whole this mechanism, a COIDS software give an individual profile there is no chance move one's personal information into wrong hand except the corruption, hacking or tampering with DNA evidence is not involved [24]. UK also have a database system which combined with different countries database system [3].

Discussion

DNA proved an innocence as well as a guilty person. Errors can be made when samples are collected. DNA evidence is completely conclusive if the samples have not been contaminated. The lack of suitable experiments leads to the wrong perception, but advancement in molecular genetics avoid the types of contamination. Allowing the trained person to educate the public about DNA reliability. Allowing new technologies which show acceptance towards common

people, make standardized tools and technologies of DNA typing. People think that there is a chance to misuse the data from DNA database by enforcing agencies. COIDS used DNA data only for identification but to proof identity not the whole genome required only core 13 loci is enough for identification and after keeping core 13 loci the remaining DNA should be carefully dispose-off if it is not required and one more thing is that 13 loci enough for identification it cannot give complete medical information of an individual.

Conclusion

DNA evidence is not a reliable tool for criminal, experts have warned because there are man-made mistakes occur which lead to the wrong consequences. A study has found that interpretation of samples can be highly subjective and prone to error. The incredibly small amount of DNA in samples and pressure to gain a conviction can lead to bias results. Although the margin to biological challenges is near to nothing, the room for human mishandling always here. Poor laboratory practices can lead to false results. There is a possibility that DNA at crime scene replaced by another person, who was not a criminal actually. Forensic DNA typing had a tremendous positive impact in the criminal justice system but its reliability should not be taken granted. DNA of each and every person is a God's signature which discriminate every individual but our carelessness make it fragile which arise questions at its reliability.

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