RESEARCH PAPER

Evaluation of the Constitutional and Legal Significance of DNA Profiling in Paternity Cases and Criminal Investigations

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Abstract

Forensic evidence plays a critical part in criminal investigations. They frequently help identify criminals based on the evidence they leave behind and are very accurate. DNA, also referred to as deoxyribonucleic acid, is a special biological blueprint found in our bodies. This element, which is found in every cell in a person's body, can be used to identify them. Two people cannot have the same DNA unless they are identical twins. Criminals whose cells, hair strands, blood, tissues, semen, or bodily fluids were inadvertently left at the crime scene can be identified using DNA profiles. DNA profiling has fundamentally reshaped forensic science, offering a precision that was once unimaginable in the pursuit of justice. While it has become a cornerstone of both successful prosecutions and the exoneration of the innocent, its reliability is not absolute. Practical challenges ranging from sample contamination to the misinterpretation of complex data can still lead to the kind of judicial errors that shake public trust. This research explores the scientific foundations of DNA evidence, specifically the mechanics and constraints of PCR and STR analysis. It further critiques the legal landscape, comparing the U.S. Daubert Standard with Section 39 of the Bharatiya Sakshya Adhiniyam. By examining real-world cases where flawed forensics led to wrongful convictions, this study advocates for stronger procedural safeguards and judicial literacy to ensure DNA remains a tool for truth, not a risk to privacy. DNA testing is also helpful in cases of maintenance, rape and paternity disputes.

Keywords: Constitutional dimensions, DNA profiling, DNA evidence, Forensic Investigation, Paternity

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Introduction

DNA evidence has become a fundamental component of contemporary forensic investigations. It is regarded as one of the most reliable forms of evidence because DNA is unique to each individual, except in the case of identical twins. The increasing reliance on DNA evidence in legal proceedings has prompted important discussions regarding its reliability, limitations, and potential for misuse. The field of forensic science now heavily depends on DNA profiling, which originated as genetic fingerprinting in the 1980's and has since become an essential investigative tool. The use of DNA evidence has significantly enhanced the accuracy of criminal investigations by enabling the comparison of biological samples collected from crime scenes with suspects' DNA profiles. As a result, DNA evidence has contributed to a substantial number of criminal convictions. However, the growing dependence on DNA technology necessitates a critical evaluation of its dependability and inherent risks. DNA analysis begins with the extraction of genetic material from biological sources such as blood, saliva, hair, or skin cells.[1] Forensic experts then conduct a series of tests to establish a distinct genetic profile. The most widely used techniques in forensic DNA analysis include Polymerase Chain Reaction (PCR) and Short Tandem Repeat (STR) analysis. Despite its scientific rigor, DNA evidence is not immune to errors. Improper sample collection, contamination, degradation, or mishandling can compromise reliability and lead to incorrect legal outcomes.[2] Finding a match between a suspect and a crime scene using DNA fingerprints is a difficult process that depends more on chance than most people believe. DNA databases run by the government do expedite the process, but they also highlight difficult moral dilemmas pertaining to the rights of both suspects and victims. To fully grasp the ethical and legal implications of forensic genetics, one must comprehend how DNA evidence is collected and examined, what it might reveal to investigators, and how it is applied in the judicial system. While DNA evidence provides powerful and legally admissible proof, it also raises significant ethical and privacy concerns. DNA databases play a crucial role in solving cold cases and identifying repeat offenders, but they also pose risks related to unauthorized access, data misuse, and privacy violations.[3] The practice of familial DNA searching has further intensified these concerns, as relatives

of suspects may inadvertently become subjects of criminal investigations. Although DNA evidence is grounded in strong scientific principles, it cannot provide absolute certainty. The risks of false positives, laboratory errors, and judicial misinterpretation underscore the need for strict procedural safeguards. The criminal justice system must strike a careful balance between leveraging DNA technology to enhance accuracy and ensuring adequate protections against its potential misuse.

This paper encompasses the objective of reviewing the Indian statutes and constitutional law pertaining to DNA evidence in paternity, rape, and murder cases. It also discusses significant rulings and the evolution of judicial principles related to the DNA evidence highlighting landmark cases in India and abroad.

Literature Review

Following the development of genetic technology, the use of DNA evidence has become a prominent area of judicial and scientific investigation. Initially, blood grouping and serological testing were used for identification and paternity determination. These techniques were commonly inaccurate and unable with time to yield definitive results so as to provide extremely trustworthy scientific evidence that may almost certainly establish biological ties and individual identification. The introduction of DNA profiling changed this profession. DNA evidence has developed into a crucial investigative and evidential tool in criminal justice, particularly in situations of rape, sexual assault, homicide, and other serious offenses, even outside of paternity disputes. [4]

Another significant point addressed here is the constitutional dimensions of DNA testing. In the landmark judgment in Justice K.S. Puttaswamy v. Union of India (2017),[5] privacy has been recognized as a fundamental right under Article 21 of the Constitution. Also, cases such as Goutam Kundu v. State of West Bengal (1993),[6] Banarsi Dass v. Teeku Dutta (2005)[7] and Nandlal Wasudeo Badwaik v. Lata Nandlal Badwaik (2014)[8] reveal a gradual shift in judicial attitudes. Earlier decisions prioritized the protection of family relationships and legitimacy presumptions, whereas more recent judgments demonstrate a greater willingness to rely on scientific evidence where it serves the interests of justice. This evolving jurisprudence reflects the judiciary's attempt to balance competing interests, including the search for truth, the welfare of the child, and the protection of individual rights.

The admissibility of DNA evidence varies across legal systems. In the United States, courts rely on the Daubert Standard to assess the admissibility of scientific evidence, which requires proof of scientific validity and relevance. In India, Section 39 of the Bharatiya Sakshya Adhiniyam, 2023 permits the admissibility of DNA evidence when supported by qualified expert testimony.[9] Despite these legal frameworks, courts often face challenges in interpreting DNA findings, particularly when complex statistical probabilities are involved.

Legislative Provisions

The Bharatiya Sakshya Adhiniyam, 2023, which replaced the Indian Evidence Act, 1872, constitutes the primary statutory framework governing the admissibility and evaluation of evidence in India. The Act does not contain specific provisions exclusively dealing with DNA testing in paternity disputes, several sections provide the legal basis for the consideration of scientific and forensic evidence by courts. Section 39 of the Bharatiya Sakshya Adhiniyam, 2023 held that the relevance of expert opinions on matters requiring specialized knowledge, including science, medicine, and forensic analysis. DNA profiling falls within the ambit of scientific expertise, enabling courts to rely upon forensic experts and laboratory reports when determining issues relating to biological parentage. DNA test reports are admissible as expert evidence and often serve as crucial material in resolving paternity disputes.

Section 116 upholds the conclusive proof about the legitimacy of a child born during the continuation of a lawful marriage or within 280 days following its dissolution. This clause aims to preserve family stability and safeguard children's position and validity. However, as DNA technology has advanced, courts have seen more instances where scientific evidence contradicts legislative presumptions. In the search for biological truth, judicial rulings have so concentrated on striking a balance between the conclusive presumption under Section 116 and the evidential value of DNA testing.

Sections 61 to 63 of the Bharatiya Sakshya Adhiniyam, 2023 accords equal legal recognition to electronic and digital records as documentary evidence. Although these provisions primarily govern electronic evidence, they underscore the importance of authenticity, reliability, and procedural integrity in the collection and presentation of evidence.[10] Similar principles apply to DNA evidence, where maintaining proper chain of custody, preserving sample integrity, and ensuring accurate laboratory procedures are essential for establishing the evidentiary value of genetic test results.[11]

The Bharatiya Sakshya Adhiniyam, 2023 thus provides a modern evidentiary framework that accommodates scientific and technological advancements while simultaneously safeguarding established legal presumptions and procedural fairness. In paternity disputes, courts must carefully balance expert DNA evidence with statutory protections, constitutional rights, and considerations of child welfare to ensure a just and equitable determination. [12]

The Hindu Adoption and Maintenance Act,[13] and the Hindu Marriage Act,[14] 1955 continue to play a significant role in disputes involving maintenance, legitimacy, inheritance, and parentage. In particular, Sections 18, 20, and 21–22 of the Hindu Adoption and Maintenance Act, 1956 govern the maintenance rights of wives, children, aged parents, and certain dependants, while Section 24 and Section 25 of the Hindu Marriage Act, 1955 provide for interim maintenance and permanent alimony. In cases where the determination of biological parentage directly affects entitlement to maintenance or inheritance, courts may rely upon DNA evidence to ascertain the existence of a biological relationship. Procedural aspects relating to the collection, preservation, and presentation of biological evidence are governed by the Bharatiya Nagarik Suraksha Sanhita, 2023 (BNSS)[15]. Specifically, Sections 51 and 52 of the BNSS authorize the medical examination of accused and arrested persons and permit the collection of biological samples, including blood, semen, hair, swabs, and other bodily

substances, for forensic analysis and DNA profiling. These provisions facilitate the use of modern scientific techniques in judicial proceedings and provide the statutory foundation for the admissibility and evaluation of DNA evidence. Together, these legal frameworks ensure that scientific evidence is integrated into the adjudication of maintenance and inheritance disputes while maintaining procedural fairness and protecting individual rights.

Constitutional principles governing DNA

DNA testing in paternity disputes engages several constitutional protections, particularly the rights to privacy, personal liberty, equality before the law, and protection against self-incrimination.[16] Indian courts have consistently sought to balance the probative value of scientific evidence with the preservation of fundamental rights guaranteed under the Constitution.

The right to privacy was unequivocally recognized as a fundamental right under Article 21 by the Supreme Court in Justice K.S. Puttaswamy (Retd.) v. Union of India (2017) SCC 1. The SC held that privacy encompasses bodily integrity, informational autonomy, and decisional freedom. DNA testing directly implicates these interests because it involves the collection of biological samples and the disclosure of sensitive genetic information.

Subsequently, in Ashok Kumar v. Raj Gupta,[17] the Supreme Court observed that while DNA testing is a valuable scientific tool for determining paternity, courts must exercise caution before directing such tests because they may intrude upon an individual's privacy and dignity. Orders for DNA testing should therefore be issued only when they are necessary for a just adjudication of the dispute and when less intrusive means of proof are inadequate.

Article 14 guarantees equal protection of laws and safeguards individuals against arbitrary state action. In paternity disputes, this principle requires courts to ensure that directions for DNA testing are based on objective criteria and are applied uniformly to all parties. Judicial discretion must be exercised fairly so that no party is subjected to discriminatory or unreasonable compulsion.

The Supreme Court of India in its case- Dipanwita Roy v. Ronobroto Roy**[18]** emphasized that DNA testing may be directed where it is essential for resolving a material issue before the court, but such orders must be founded on a rational and legally justifiable basis, thereby reflecting the constitutional mandate of fairness and equality.

Article 20(3) protects individuals from being compelled to be witnesses against themselves in criminal proceedings.[19] The scope of this protection was examined in State of Bombay v. Kathi Kalu Oghad[20], where the SC distinguished between testimonial compulsion and the collection of physical evidence. The SC held that obtaining physical evidence, such as fingerprints, handwriting samples, or other bodily evidence, does not ordinarily amount to self-accusation.

Applying this principle to DNA profiling, courts have generally regarded the collection of biological samples as the acquisition of physical evidence rather than compelled testimony. Nevertheless, judicial supervision remains essential to ensure that DNA testing is conducted in a manner that respects constitutional safeguards. The Supreme Court in Ashok Kumar v. Raj Gupta reiterated that DNA testing should not be ordered routinely and that courts must carefully weigh the interests of privacy, dignity, and fairness against the evidentiary value of the test.

Advantages Of DNA Evidence

Advantages of DNA evidence is its objectivity and high degree of scientific accuracy. Unlike circumstantial evidence, witness testimony, or presumptions of legitimacy, which may be influenced by human error, bias, or subjective interpretation, DNA testing provides a statistical probability of biological parentage. This scientific certainty reduces the likelihood of prejudice and misjudgment in legal proceedings. Furthermore, DNA evidence can resolve disputes quickly and conclusively, particularly in cases where other forms of evidence are conflicting or insufficient. In family law matters such as maintenance, child custody, inheritance, and paternity disputes, DNA testing serves as a reliable means of establishing biological relationships. As a result, courts increasingly recognize DNA evidence as an effective tool for promoting fairness, accuracy, and efficiency in judicial decision-making.

Disadvantages of DNA evidence

Despite its benefits, DNA evidence also has certain disadvantages. DNA testing can be costly and may not be readily accessible to all individuals, particularly in resource-constrained settings. Concerns regarding privacy and the potential misuse of genetic information may also arise. Additionally, laboratory errors, sample contamination, or mistakes in handling and interpretation can affect the reliability of test results. In some cases, an overreliance on DNA evidence may overlook important social, emotional, or legal considerations, especially in family relationships where biological connections are not the sole determining factor. Therefore, while DNA evidence is a powerful and reliable form of proof, it should be evaluated alongside other relevant facts and circumstances in legal proceedings.

Scientific Anomalies

The existence of two genetically different cell lines in an organism is either inherited or obtained through the infusion of allogeneic hematopoietic cells during transfusion or transplantation. Chimerism in fraternal twins is caused by blood-vessel anastomoses. Tetragametic chimerism, a less frequent type of congenital chimerism, is the result of two spermatozoa fertilizing two eggs, fusing the zygotes, and creating an organism with mixed cell lines. Conventional STR-based DNA testing may result in false exclusions in extremely uncommon biological situations. In these situations, a paternity test may mistakenly rule out a biological parent if the analyzed DNA comes from a different cell line than the one the child received. 21 Even though tetragametic chimerism is not a common legal defense, courts have acknowledged that where standard DNA results are at odds with other evidence, unique genetic findings may call for more research and expert genetic analysis.

Karen Keegan case[22]

Fact of the Case:

Renal failure affected a 52-year-old woman. The patient and her immediate family underwent histocompatibility testing prior to receiving a kidney donation. The patient's husband's HLA haplotype and a distinct set of HLA determinants, rather than one of the typical maternal haplotypes, indicated that the woman could not be the biologic mother of two of her three sons. Testing of multiple tissues showed that different parts of her body carried different DNA profiles. Researchers concluded she had tetragametic chimerism: she had absorbed cells from a fraternal twin during embryonic development.

Significance

- This is one of the first medically documented cases proving that a woman can carry two distinct genomes.
- It demonstrated that standard DNA parentage testing can occasionally be misleading.

Lydia Fairchild Case[23]

Fact of the Case:

Records of Fairchild's previous child births were questioned and she was accused of fraud by either participating in a surrogacy scam or claiming benefits for other people's children. Prosecutors demanded that her two children be removed from her because they didn't think they belonged to her. When the time came for her to give birth to her third child, the judge mandated that an observer be present, make sure that Fairchild and the kid's blood samples were collected right away, and be prepared to testify. DNA tests two weeks later appeared to show that she was not the child's mother either. The court ordered additional DNA tests from other labs to rule out any possibility of human mistake. However, the outcomes were identical: She didn't own the kids. The majority of the lawyers Fairchild sought were unwilling to contest DNA evidence.

Significance

- This case became a landmark legal case showing that DNA evidence is highly reliable but not infallible in extremely rare biological situations.

Chimerism-induced paternity confusion Case[24]

This case was reported in Journal of Assisted Reproduction and Genetics (2017)

Fact of the Case:

According to research in the Journal of Assisted Reproduction and Genetics, a 34-year-old man sought assistance after recurrent PCR-based paternity testing and routine blood tests produced false-exclusion results, meaning he could not be his child's biological father. An uncle-nephew biological relationship was discovered through microarray technology, even though the man's primary genetic profile did not match the baby's. Additional research revealed that his sperm contained DNA from his absorbed "twin," which essentially meant the man was serving as a genetic vehicle for his unborn brother. The genome of the absorbed twin may actually be found in the father's reproductive organs rather than the one found in the tissue under evaluation. Such disparities may have shave demonstrated that the true biological link was only determined following thorough genetic testing of various tissues.

Significance

- This incident draws attention to a crucial flaw in conventional "gold standard" paternity testing techniques including blood-based DNA testing and buccal (cheek swab) testing. The underlying premise of these tests is that a person's genetic profile is the same across all of their body's cells. This assumption does not, however, apply in rare instances of human chimerism. An individual with two genetically different cell populations is called a chimaera; this is frequently the outcome of two embryos fusing together early in development. A DNA sample from the cheek or blood may not precisely reflect the genetic composition of the reproductive cells (eggs or sperm) since these distinct cell lines may be unevenly distributed across different tissues and organs.
- These rare but significant cases demonstrate the need for greater awareness of chimerism among medical professionals, genetic counselors, and legal authorities when interpreting DNA test results that appear inconsistent with known family relationships.

R v. Doheny; R v. Adams Case[25]

(Court of Appeal, England and Wales).

The use and presentation of DNA evidence in criminal prosecutions was at issue in the appeals in Doheny and Adams. DNA profiles from samples taken at the crime site matched the profiles of the defendants in both cases. The prosecution suggested that there was very little possibility of a fortuitous match by presenting incredibly low random-match odds. The Court of Appeal's main concern was how statistical DNA evidence should be presented to a jury rather than the scientific validity of DNA profiling per se.

Indian Courts' Approach (Landmark Cases):

Kattavellai @ Devakar v. State of Tamilnadu[26]

Fact of the Case:

The defendant was found guilty of rape and given the death penalty. The Supreme Court discovered significant flaws in DNA sample collection, preservation, transportation, and documentation during an appeal. The prosecution's case was undermined and the accuracy of the DNA results was impacted by the improper handling of forensic evidence.

Significance

- The Supreme Court released national guidelines for managing DNA evidence, including criteria for recordkeeping, sample preservation, chain-of-custody regulations, and transit practices.

The Court made it clear that while DNA evidence is extremely significant, its evidential value must be preserved via scientific handling.

R. Rajendran v. Kamar Nisha[27]

Fact of the Case:

Kamar Nisha wedded Abdul Latheef. Later, she claimed that Dr. R. Rajendran, who had visited her family for medical care, became close to her. In 2007, while she was still legally married to Abdul Latheef, a child was born. In an attempt to prove that Dr. Rajendran was the child's biological father, Kamar Nisha filed criminal charges for cheating and related offenses. In order to establish paternity, the High Court ordered Rajendran to undergo DNA testing.

Significance

- The High Court's judgment requiring DNA testing was overturned by the Supreme Court, which concluded that it is not possible to order a DNA test on a regular basis just because it might expose the biological truth.
- Unless there is unmistakable evidence of non-access between the spouses, Section 112's presumption of legitimacy is maintained.
- Mandatory DNA testing is a grave violation of people's right to privacy, dignity, and bodily autonomy.
- Ordering a DNA test was not warranted because paternity was merely a collateral issue and had nothing to do with establishing the accused offenses.

Dhiraj @ Dhiru Prakash Panchal v. State of Maharashtra[28]

Fact of the Case:

The case started when multiple defendants were found guilty of serious sexual offenses against the prosecutrix. The prosecutrix's testimony served as the main foundation for the prosecution's case, which was bolstered by a variety of corroborating evidence, such as call detail records, medical evidence, DNA evidence, and a Test Identification Parade. The DNA profile of one accused did not match the prosecutrix. The Bombay High Court considered whether the trial court had appropriately evaluated the evidence that led to the accused's conviction during the appeal.

Significance

- The DNA findings' evidentiary value and whether they adequately linked the accused to the crime when taken into account in conjunction with the victim's testimony and other supporting evidence were among the main concerns.

The ruling illustrates the contemporary court perspective that, despite DNA evidence's great reliability, it is not necessarily decisive when considered alone and must be evaluated in the context of the case's larger evidential framework.

Goutam Kundu v.State of West Bengal &Other [29]

Fact of the Case:

This case delt with maintenance proceedings involving Goutam Kundu and his spouse, Shaswati Kundu. During their marriage, a daughter was born. The husband claimed he was not the child's biological father and contested the child's paternity. He requested a blood group test of the child and the parties in order to establish non-paternity and prevent maintenance liability. The request was denied by the trial court.

The Court established crucial rules:

1. Blood testing cannot be routinely ordered by Indian courts. A roaming paternity investigation should not be the purpose of blood testing.
2. Before ordering such a test, there must be a compelling prima facie case.
3. The ramifications of labeling a kid as illegitimate must be taken into account by the courts.
4. Without a valid legal reason, no one may be forced to provide a blood sample.
5. It established that courts must weigh scientific evidence against the child's rights, dignity, and status and that genetic testing should not immediately supersede the legal assumption of legitimacy.

Nandlal Wasudeo Badwaik v.Lata Nandlal Badwaik & Anr.[30]

Fact of the Case:

The paternity of a girl child born during his marriage was contested by the spouse, Nandlal Wasudeo Badwaik. For both herself and the child, the wife requested maintenance. A DNA test was performed through the hearings. The DNA analysis unequivocally demonstrated that the husband was not the child's biological father.

Significance

- One scientifically accurate and trustworthy way to establish paternity is through DNA testing.
- The court should not disregard the reality that science has revealed when there is a clear disagreement between a legal presumption and conclusive scientific evidence.
- In this instance, the DNA test disproved the Section 112 (Section 116 of Bharatiya Sakshya Adhiniyam, 2023) presumption.
- Consequently, when scientific evidence proved beyond a reasonable doubt that the spouse was not the biological father, he could not be forced to acknowledge fatherhood.

Conclusions

DNA profiling offers a remarkably precise and scientifically trustworthy means of identification in criminal investigations and paternity issues and has completely transformed the administration of justice. In cases of rape, murder, maintenance, inheritance, and contested parentage, its implementation has greatly improved the courts' capacity to determine the truth. DNA evidence has emerged as one of the most potent types of forensic proof available to our present legal systems, as evidenced by court rulings in India and comparative worldwide experiences.

However, there are significant ethical, legal, and constitutional issues with the growing reliance on DNA technology. Article 21 of the Constitution's fundamental rights to privacy, dignity, physical integrity, and personal liberty are directly impacted by the gathering, storing, and use of genetic data. Justice K.S. Puttaswamy v. Union of India's acknowledgment of privacy as a basic right has reaffirmed the need to make sure that DNA testing is only carried out where there is a strong legal need and sufficient procedural protections.

However, uncommon scientific abnormalities like tetragametic chimerism show that DNA evidence is not perfect, despite its high reliability. Cases like Karen Keegan, Lydia Fairchild, and reported cases of chimerism-

induced paternity confusion show that if DNA data is evaluated without sufficient scientific understanding, unique biological circumstances may result in misleading outcomes. These instances highlight the significance of expert testimony, careful judicial evaluation, and strict respect to forensic standards.

A major step toward updating India's evidential and procedural framework has been taken with the passage of the Bharatiya Sakshya Adhiniyam, 2023 and the Bharatiya Nagarik Suraksha Sanhita, 2023. Nonetheless, India currently lacks a thorough legal framework controlling the gathering, storing, utilizing, preserving, and discarding of genetic data. The planned DNA Technology (Use and Application) Bill is still a significant piece of legislation in this regard. The significance of protecting sensitive genetic data through strong procedures for informed consent, confidentiality, data security, laboratory certification, chain of custody, and management of DNA databases is further highlighted by the Digital Personal Data Protection Act, 2023. These legal protections are necessary to stop abuse, guarantee the validity of DNA evidence, and preserve public trust in the legal system.

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