

COMMENTARY

Conclusiveness of DNA Reports in Indian rape cases: procedural challenges and judicial caution

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Abstract

DNA profiling is considered a scientifically reliable tool for identifying perpetrators and exonerating the innocent. However, its role in Indian rape cases is generally regarded as corroborative rather than conclusive. Judicial scepticism stems from the likelihood of procedural deviations in sample collection, preservation, and handling, along with a preference for traditional evidence such as eyewitness testimony. Inconsistent judicial interpretation, multiplicity of forensic protocols, judicial backlogs, inadequate infrastructure/workforce, and delay tactics compound the problem. Statutory provisions permit DNA sample collection without defining "DNA profile", the use of force in obtaining bodily measurements, and the prolonged retention of DNA data. These factors raise concerns over genetic privacy, human dignity, and informational overreach. The probative value of DNA evidence remains contingent upon the adoption of uniform and binding forensic protocols with embedded legal sanction, effective regulatory oversight, strict adherence to prescribed standards, infrastructure/trained manpower augmentation, and judicial sensitisation to evolving DNA technologies.

Keywords: DNA profiling, rape trials, forensic evidence, Indian judiciary, evidentiary value

Introduction

Forensic scientists hail DNA profiling as one of the most accurate methods for establishing a person's identity [1]. However, its accuracy is not absolute and there remains the possibility of error [2], due to non-adoption of established protocols in collecting, storing, transporting, or preserving samples, leading to their alteration, tampering or contamination. Forensic errors are broadly of three types, viz systematic, random, and negligent [3]. Systematic errors are caused by instrumental flaws, procedural misconfiguration, algorithmic misapplication, or environmental factors [4]. Random errors result from unpredictable fluctuations in measurements [5]. Negligent errors are triggered by human inexperience or oversight [6]. Although technological advancements such as next-generation sequencing [7] and automated DNA extraction methods [8] have improved the precision of DNA analysis, they do not address issues that arise before samples reach the laboratory. In India, there has been minimal progress in developing forensic protocols and optimising sample collection and preservation [9]. Inaccurate results may be due to lapses at the testing, analysis, or

interpretation stage [10]. Moreover, analysis of DNA fragments cannot distinguish monozygotic twins, which risks the generation of false positive results. This may, however, be resolved through contemporary techniques [11].

DNA profiling has three major applications in criminal law: identification of perpetrators of crime, exculpation of wrongly accused suspects, and identification of the remains of victims of violent crimes [12]. However, its use and admissibility can vary significantly depending on the nature of the crime and the legal context within which it is applied. Such deployment of DNA technology raises ethical concerns about genetic privacy violation, forcible obtainment of biological samples that jeopardise human dignity and induce psychological harm, and informational overreach in DNA data collection and retention.

In India, the Criminal Procedure (Identification) Act, 2022 (Identification Act), along with the Criminal Procedure (Identification) Rules, 2022 (Identification Rules), lays down provisions to regulate the taking, collection, storing, and preservation of DNA evidence, and the sharing, dissemination, destruction, and disposal of records. At present, Chapter V of the Bharatiya Nyaya Sanhita, 2023 (BNS) deals with the offence of rape. Section 51 of the Bharatiya Nagarik Suraksha Sanhita, 2023 (BNSS), the law that governs criminal procedure, allows for the examination of an accused by a registered medical practitioner at the request of a police officer. It defines "examination" to include the analysis of biological samples using DNA profiling. While Section 52 pertains to the medical examination of a rape accused, Section 184 deals with the examination of the victim, with their consent. Detailed reporting, including observations on physical injuries and mental condition by forensic experts, and videographic recording of the process, has been mandated for proper evidence collection.

Judicial stance in cases of contradictory DNA evidence

In offences of rape, Indian courts have almost always considered DNA evidence inconclusive, with emphasis placed on other more reliable forms of evidence [13]. In several recent judgments since 2022, the High Courts have preferred consistent direct evidence to contradictory DNA reports, primarily because of uncertainty regarding the preservation of DNA samples [14–16].

Such rulings *prima facie* suggest that contradictory DNA evidence has no bearing on the judicial outcome. However, this stance is not entirely correct. To secure a conviction, Indian criminal law requires that the guilt of the accused be proven beyond reasonable doubt. Section 104 of the Bharatiya Sakshya Adhiniyam, 2023 (BSA) states that the party which alleges the commission of an offence must prove it. Despite the inconclusiveness of DNA evidence, negative DNA reports are sufficient to create doubt in the judges' minds and consequently stall conviction [15, 17, 18]. The Supreme Court has held that in cases with a negative DNA report, rulings would be based on other materials and evidence on record [19]. The evidentiary value of DNA evidence has been equated to that of opinion evidence as contained in Section 45 of the Indian Evidence Act, 1872 (IEA), now replaced by Section 39 of the BSA, and thus, its probative value is deemed to vary from case to case [20].

Principles derived from judgments

The inconclusive nature of DNA evidence arises not from its scientific unreliability, but from two principal factors:

- i) Deviations from established protocols regarding samples, such as proper documentation, collection, packaging, and preservation, without which they may be altered or contaminated, as also negligence of the laboratory or analyst [20], and
- ii) Judicial preference for more cogent and traditional forms of evidence [21], arising out of the present unreliable nature of DNA evidence [22].

The Supreme Court has observed that for DNA evidence to be admissible in a court of law, it must be properly documented, collected, packaged, and preserved according to legal and scientific standards that include the use of sterile collection tools, appropriate storage temperatures, and documented chains of custody. The physical evidence upon which the DNA test is conducted should reach the laboratory without being tampered with [23]. The reliability of DNA testing is also dependent on quality control and quality assurance procedures in approved laboratories [24], along with the credibility and competence of the analyst [25].

The courts have followed the principle that consistent oral evidence and documentary evidence, whether primary or secondary, outweigh the veracity of DNA evidence. Yet, eyewitness reports are not always dependable because of a convergence of memory and social-influence variables that interact intricately [26]. At the same time, statements given by the accused and recorded in police custody fall under Section 25 of the IEA and cannot be treated as extra-judicial confession [27]. Indirect evidence, on the other hand, relies on inference and deduction to establish facts. The presence of a "clinching DNA report" against an accused does not automatically result in their conviction if contradictory witness testimonies exist [28].

The debate over the conclusiveness of DNA reports depends on balancing scientific objectivity with established legal principles. This discord is significant since treating DNA as infallible may inadvertently overshadow other critical aspects of the case, such as motive, opportunity, and intent.

Insights from NCRB statistics and the multiplicity of protocols

The Ministry of Home Affairs' National Crime Records Bureau (NCRB) report Crime in India 2022 shows that 4,45,256 cases of crime against women were registered in 2022, amounting to a 4% increase over 2021. Out of the total number of cases, 7.1% were registered as rape. During 2022, a total of 1,62,449 cases of crime against children were registered, revealing an increase of 8.7% over 2021. Offences under the Protection of Children from Sexual Offences Act, 2012 (POCSO Act) amounted to 39.7% which included child rape [29].

The NCRB data presented in Table 1 reveal that on average, 92.02% of cases across all categories of rape remain pending in courts. This shows how long-drawn-out rape trials can be in India. Delays in the judicial process exacerbate the trauma experienced by victims and undermine public confidence in the justice system [30]. These delays may be ascribed to insufficient judicial infrastructure, backlog of cases, procedural inefficiencies, workforce shortage, victim and witness intimidation, and delay tactics employed by the accused. Conviction rates are also concerningly low for grave offences such as murder combined with rape or gang rape, as well as crimes under the POCSO Act, with the average standing at 6.86%. This suggests challenges in proving cases beyond a reasonable doubt, possibly due to inadequate investigation, lack of evidence, or witnesses being unavailable or turning hostile. The high average acquittal rate of 8.25% could indicate systemic issues including, *inter alia*, poor investigation, faulty/insufficient evidence collection, and victim/witness intimidation.

At present, India lacks a comprehensive set of binding forensic protocols. From 2014-2022, numerous and disparate forensic guidelines for sexual assault cases were framed. In 2014, the Ministry of Health & Family Welfare formulated medico-legal care guidelines for uniform medical evidence collection [31]. The Directorate of Forensic Science Services subsequently developed forensic evidence guidelines for investigating officers and medical practitioners (2018) [32, 33], a working procedure manual for DNA testing (2019) [34], a standard list for Forensic Science Laboratory (FSL) equipment establishment/upgradation (2020) [35], and a standard operating procedure for crime scene investigation (2022) [36]. Protocols/guidelines for the examination of sexual offence survivors have also been issued by states such as Maharashtra [37] and Kerala [38]. In 2020, the National Human Rights Commission (NHRC) developed and issued to all the states and union territories a standard operating procedure for evidence collection to ensure effective prosecution that could lead to conviction in sexual

Table 1. Court Disposal of Cases Related to Rape Against Women and Children (2022)

Crime Category	Total Cases for Trial	Conviction Rate (%)	Acquittal Rate (%)	Pending Cases (%)
Murder with Rape / Gang Rape (Women)	464	9.27%	4.09%	95.2%
Murder with Rape / POCSO (Children)	708	4.8%	1.13%	94.1%
Rape (Women)	44,785	11.32%	26.94%	90%
Rape (Children)	26,605	3.37%	3.6%	92.4%
POCSO Act (Section 4 & 6 r/ w Section 376 IPC)	158,827	3.54%	7.49%	88.4%
Average (%)		6.86%	8.25%	92.02%
<i>Note:</i> Data analysed in the table is sourced from "Crime in India 2022: Statistics - Volume-I" by National Crime Records Bureau, Ministry of Home Affairs, Government of India, 2023, (https://ncrb.gov.in/uploads/nationalcrimerecordsbureau/custom/1701607577CrimeinIndia2022Book1.pdf).				

assault cases [39]. Moreover, Central FSLs (CFSLs), State FSLs (SFSLs), and Regional FSLs (RFSLs) often develop their own distinct SOPs and manuals.

The multiplicity of existing protocols presents its own set of challenges, particularly heterogeneity and the difficulty in determining which to adopt. Further, due to their recommendatory nature, there are neither any penal consequences for non-compliance, nor is there any accountability mechanism to enforce adherence. In addition, the discretion exercised by Indian courts in ascertaining the probative value of DNA evidence results in inconsistent judicial interpretations. The creation and enforcement of a standardised and binding legal framework for forensic evidence would enhance its credibility and establish uniformity in determining its evidentiary weight, thus speeding up the dispensation of justice.

Policy incoherence, rights issues and systemic shortcomings

Privacy and the undefined scope of DNA profiling

Implementation of DNA technology in criminal investigations may trigger privacy issues [40]. The BNSS enables the collection of samples from rape accused and rape victims for DNA profiling but does not define "DNA profile." This creates ambiguity regarding what aspects of genetic information can be used. Non-coding DNA should ideally be used for forensic purposes as it does not reveal personal traits or health-related information and thus protects genetic privacy [41]. However, Indian laws do not distinguish between coding and non-coding DNA. Consequently, there arises a risk of over-collection of data that threatens genetic privacy. Thus, it is recommended that the law be amended to define "DNA profile" as including only non-coding DNA.

Use of force and the risk of coercion in DNA collection

Section 52 of the BNSS, which facilitates the examination of a rape accused by a medical practitioner at the behest of a

police officer, permits the use of force as is "reasonably necessary" for that purpose. While no standards for such "reasonableness" are prescribed in the statute, discomfort and pain caused in the process of collection of biological samples have been held to be justified [42, 43]. Resistance or refusal to allow the obtainment of measurements under the Identification Act is penalised under Section 221 of the BNS. At the same time, the Supreme Court states that investigating authorities ought to adopt steps to prevent the violation of the constitutional rights of the accused [44]. These assertions seem contradictory, and the current law appears to prioritise investigative needs over individual rights. The use of force can create an environment of coercion and intimidation [45]. Additionally, police brutality can have lasting consequences for the accused, such as psychological distress [46], PTSD [47], and suicide ideation [48]. Therefore, even when non-consensual collection of DNA evidence is deemed necessary, every attempt should be made to obtain informed consent from the accused, simultaneously maintaining sensitivity and respect for the individual's dignity.

Constitutional safeguards and the risk of overreach

Policymakers should ensure that the chances of misuse of DNA technology against public interest are reduced [49]. In addition, it is a well-settled judicial position that the collection and retention of biological samples do not affect the right against self-incrimination under Article 20(3) of the Constitution [50, 51]. Therefore, criminal investigations cannot be obstructed by invoking constitutional protections. This position, while legally sound in its current interpretation, raises concerns about its use in justifying intrusive investigative practices that undermine fundamental rights. In this context, courts must remain vigilant and exercise the power of judicial review to ensure that forensic investigations comply with the constitutional principles of fairness and due process.

Lack of oversight and regulatory gaps in DNA data management

Under the Criminal Procedure (Identification) Act, 2022, the NCRB is responsible for maintaining DNA databases, but there is no oversight mechanism to monitor its operations. The Identification Rules envisage the issuance of Standard Operating Procedures by the NCRB (NCRB SOP) for the handling of measurement records. The statute, combined with the rules, vests unchecked and extensive powers in the NCRB. This generates the possibility of data manipulation, excessive retention, and access by unauthorised entities. Moreover, the absence of a prescribed timeline for the NCRB SOP issuance enables the indefinite storage of DNA records, even for individuals who were acquitted or discharged. Next, although the rules empower the Central/State Governments and Union Territory Administration to effectuate compliance with the NCRB SOP, neither is its obligatory character expressly specified nor is any penalty specified for non-adherence. In the vein of the United Kingdom [52], India must establish an independent regulatory body, possibly under NHRC, or an autonomous forensic oversight authority, to monitor forensic procedures.

Need for data protection and retention policies for genetic information

Rule 4(2) of the Identification Rules contemplates the storage of physical/biological samples and their analysis in the database in digital format. Punishment for unauthorised access, distribution, or sharing of data shall be as per the BNS and the Information Technology Act, 2000. In this regard, the Digital Personal Data Protection Act, 2023 should be linked to the Identification Act, so that the protection afforded to digital personal data is extended to genetic data. Further, the Identification Rules should be amended to introduce strict retention policies ensuring that DNA records of those acquitted or discharged or those from whom physical/biological samples were collected unlawfully are deleted immediately. This will secure compliance with the fundamental right to be forgotten [44]. Besides, all stored DNA data should be periodically reviewed by an independent oversight authority, as proposed above, to prevent misuse.

Forensic delays, government initiatives, and strategic reforms

In November 2024, the Supreme Court identified three major reasons behind forensic delays, viz. administrative shortcomings, inadequate infrastructure, and a lack of trained manpower [53]. Earlier, in June 2024, the Union Cabinet approved the National Forensic Infrastructure Enhancement Scheme, with a financial outlay of INR 2254.43 crore, to establish 7 additional CFSs, set up 9 new campuses of the National Forensic Sciences University (NFSU), and upgrade NFSU Delhi [54]. Further, the "Scheme for Modernisation of Forensic Capacities," with a budget of INR 2080.5 crore, is intended to modernise SFSs, procure mobile forensic vans,

and augment trained personnel [55]. So far, the Ministry of Home Affairs has organised training exercises to upskill 32,524 investigating officers, prosecutors, and medical officers, besides distributing 18,020 sexual assault evidence collection kits nationwide [56]. States like Madhya Pradesh and Karnataka have stressed the need for the availability of Sexual Assault Forensic Evidence (SAFE) kits in government and private hospitals [57, 58].

To enhance forensic efficiency, a multi-pronged approach is proposed. First, the government should expedite the operationalisation of new CFSs and NFSU campuses while ensuring proper funds disbursement and utilisation. Second, recruitment and training of forensic professionals must be prioritised by introducing specialised courses and incentivising forensic careers. Specialised training of forensic experts becomes particularly crucial when the crime scene is compromised or there is a possibility of evidence tampering, such as the situation in the *RG Kar Rape and Murder case* [59]. Third, digital case tracking systems and inter-agency coordination between law enforcement and FSLs should be established. Fourth, SAFE kits should mandatorily be made available in all hospitals and personnel must be trained in their usage. Fifth, RFSs should be set up, and mobile forensic vans should be deployed strategically, especially in remote areas, to ensure timely and accessible forensic support.

The evidentiary value of DNA reports

The earlier stance of the Supreme Court was that in rape cases, the evidence of the prosecutrix needed corroboration in some measure to convict the accused [60] or ensure that the rape accused is not falsely implicated [61]. Thus, while no law mandates the corroboration of victim testimony, yet, as a matter of caution, the Court leans towards such corroboration [62]. Section 45 of the IEA allows expert opinion when the matter involves scientific or technical issues beyond the understanding of a layperson. The expert must possess specialised knowledge in the relevant field, and their evidence must be grounded in reliable principles. It is important to note that an expert's opinion serves as corroborative, rather than circumstantial, evidence meaning it is not determinant but rather advisory in nature.

The general law on the conclusiveness of circumstantial evidence is that such evidence should fulfil three conditions. First, the circumstances which conclusively determine guilt should be fully established. Second, the facts so established should be consonant with the hypothesis of the guilt of the accused. Third, the circumstances should be conclusive and bear the tendency to exclude every hypothesis, except for the one proposed to be proven. To summarise, there should not be any reasonable ground from which the inference of the innocence of the accused might be drawn [63]. When a case relies entirely on circumstantial evidence, a guilty verdict can only be justified if all incriminating facts and circumstances are shown to be inconsistent with the

innocence of the accused or the possibility of another person's guilt. These circumstances must be proven beyond a reasonable doubt and must be closely linked to the main fact being inferred from them [64].

The Supreme Court has ruled that, in rape cases, conviction can be based on the sole testimony of the prosecutrix if it inspires confidence [65]. Corroboration of such testimony is not a legal requirement, but a "guidance of prudence," and can be carried out if there exist compelling reasons to do so. However, if the Court finds it difficult to accept the testimony, it may seek evidence, direct or circumstantial, that could support her statements.

In landmark cases, the Supreme Court has used DNA evidence to corroborate circumstantial evidence. In the *Priyadarshini Mattoo* case, DNA testing was used to confirm the presence of the accused's sperm in the vaginal swabs of the rape victim. The Court found the possibility of inaccuracy remote and based the judgment on highly incriminating circumstances in addition to the DNA test results [66]. In the *Nirbhaya* case, which concerned the gang rape, brutal assault, and resultant death of the victim, the DNA profiles generated from clothes of the accused, the iron rod employed to assault the prosecutrix (and her friend), and various recovered articles were consistent with the DNA profile of the victim. Regardless, the Supreme Court based its ruling on three dying declarations, medical evidence, evidence of the injured witness and other available materials, while the matching DNA profiles were used only for corroboration [67]. In *Ravishankar v State of Madhya Pradesh*, circumstantial evidence was supported by ocular and medico-scientific evidence. DNA evidence was used to prove the sexual assault of the deceased minor girl by the appellant [68]. Citing precedents, the Supreme Court observed that DNA evidence was nearly accurate scientifically [69].

On another occasion, the Supreme Court, after considering whether DNA evidence can form the sole basis for establishing the guilt of an accused, ruled in the negative, especially when procedural lapses exist and cogent evidence is absent almost in its entirety [28]. In respect of post-conviction requests for DNA testing, the use of forensic evidence has the potential to prove the innocence of an individual and consequently exonerate him. However, the law is not clear on the realisation of this right and the procedural requirements to be followed therefor are not defined. Thus, the current state of legal incertitude is likely to make post-conviction litigation complex, expensive and time-consuming [70].

Conclusion

The evidentiary value of DNA reports in Indian rape trials remains attenuated by apprehensions about procedural lapses, inconsistent protocols, and sample integrity. Delays in forensic reporting, inadequate infrastructure, and trained manpower shortage compound the predicament. Though

these challenges diminish the reliability of DNA evidence, they do not detract from its inherent scientific reliability. Hence, standardised and legally binding protocols, capacity-building exercises for forensic professionals, and modernisation of FSLs become imperative. Simultaneously, the judiciary must adapt toward recognising DNA reports as determinative where no contradicting direct evidence exists. Courts should be sensitised to the evolving nature of forensic science to enable *informed* appreciation of DNA evidence. By implementing these reforms, DNA evidence can transcend its current status as merely corroborative and emerge as a more definitive instrument in rape adjudication.

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Conflict of Interest: None declared

Funding: None

To cite: Talukdar S. Conclusiveness of DNA Reports in Indian rape cases: procedural challenges and judicial caution. *Indian J Med Ethics*. Published online first on October 17, 2025. DOI: 10.20529/IJME.2025.077

Submission received: October 24, 2024

Submission accepted: July 4, 2025

Manuscript Editor: Sylvia Karpagam

Peer Reviewers: Three anonymous reviewers

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