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Article

Balancing Technology and Liberty: Forensic Science in the Age of Constitutional Rights and New Criminal Laws in India

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Abstract: The Indian criminal justice system is undergoing a profound transformation with the increasing integration of forensic science into investigative and trial processes. This report provides a multi-dimensional analysis of how modern forensic tools are reshaping evidence collection, evaluation, and judicial decision-making. Central to this transformation are two recent legislative reforms—the Bharatiya Nagarik Suraksha Sanhita (BNSS) and the Bharatiya Sakshya Adhiniyam (BSA)—which seek to institutionalize scientific methods of investigation and streamline evidentiary procedures. The paper examines the dual challenge these reforms face: accelerating the pace of evidence gathering while ensuring the protection of constitutional rights guaranteed under Articles 20(3) and 21 of the Constitution of India. Article 20(3) safeguards individuals from self-incrimination, while Article 21 enshrines the right to life and personal liberty, including procedural fairness. The incorporation of forensic techniques—ranging from DNA profiling to digital evidence retrieval—raises critical questions about voluntariness, consent, and the proportional use of state power. Drawing upon legal precedents, empirical research, and notable case studies, the analysis demonstrates that while forensic science strengthens the credibility of investigations, its unchecked application risks infringing upon civil liberties. Furthermore, the report identifies major implementation challenges: inadequate infrastructure in forensic laboratories, inconsistencies in procedural guidelines, shortage of trained personnel, and the absence of a comprehensive data protection framework. Unless these structural and normative gaps are addressed, the reforms risk being reduced to symbolic legislative advances rather than substantive improvements. Ultimately, the report argues that India's move towards evidence-based policing is both necessary and timely, but its success depends on balancing efficiency with fairness. Only by embedding forensic science within a constitutionally compliant and ethically grounded framework can the criminal justice system achieve both effectiveness and legitimacy.

Keywords: Forensic Science, Criminal Justice, BNSS, BSA, Constitutional Rights.

INTRODUCTION

The intersection of forensic science and constitutional law in India has emerged as one of the most transformative developments in contemporary criminal justice. The criminal trial, once dominated by eyewitness testimony, confessions, and circumstantial evidence, is now increasingly shaped by scientific techniques that promise accuracy, reliability, and efficiency. DNA profiling, fingerprint analysis, digital forensics, toxicology, and ballistics have moved from being supplementary to becoming central pillars of investigation and prosecution. This shift reflects not only technological progress but also a paradigmatic reconfiguration of the justice system itself. It marks India's transition from a system that has historically relied on oral testimony and confession-based policing toward one anchored in empirical, scientific, and ostensibly objective forms of proof.

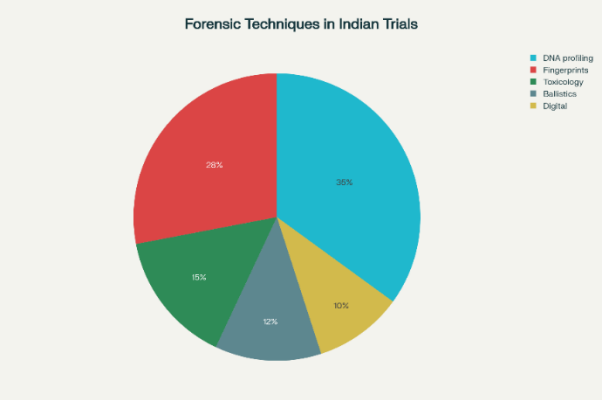

Figure 1: Distribution of Forensic Techniques in Indian Trials

Yet, this transformation does not occur in a vacuum. In a constitutional democracy such as India, technological innovations in policing and prosecution must operate within the parameters of fundamental rights and the guarantees enshrined in the Constitution. The challenge lies in balancing two seemingly competing imperatives: on the one hand, the urgent demand for efficient and accurate law enforcement; on the other, the equally compelling necessity of protecting individual liberties, dignity, and due process. The Indian Constitution, through provisions such as Article 20(3) (the right against self-incrimination) and Article 21 (the right to life and personal liberty, now interpreted to include the right to privacy and dignity), provides a robust normative framework against which forensic practices must be tested. The judiciary, through landmark decisions such as Selvi v. State of Karnataka (2010) and K.S. Puttaswamy v. Union of India (2017), has underscored that the expansion of investigative technology cannot override the core principles of human autonomy, consent, and procedural fairness.
The enactment of the new criminal laws in 2023—the Bharatiya Nagarik Suraksha Sanhita (BNSS) , Bharatiya Nyaya Sanhita (BNS) , and Bharatiya Sakshya Adhiniyam (BSA) —has made this balance even more urgent. These statutes, replacing the century-old Code of Criminal Procedure (CrPC) , Indian Penal Code (IPC) , and Indian Evidence Act, formally integrate forensic technology into the criminal process. For example, mandatory forensic investigation in cases involving punishment of more than seven years reflects a legislative commitment to scientific investigation. Likewise, provisions granting digital and electronic evidence parity with traditional forms of evidence expand the scope of admissibility and redefine evidentiary hierarchies. The reforms also envisage video documentation of crime scenes and wider deployment of forensic specialists. In short, technology is no longer a supplementary tool; it is legally mandated as an indispensable component of the justice process.

This raises crucial normative and practical questions. To what extent can the state compel an accused to submit to DNA collection or biometric identification without violating Article 20(3)? How should courts evaluate the proportionality of forensic intrusions in light of the privacy guarantees under Article 21? Can the promise of efficiency and high conviction rates justify potential risks of surveillance, misuse of data, or wrongful convictions caused by faulty forensic procedures? These questions are not abstract; they arise in real investigations and trials, where forensic evidence has determined guilt or innocence. The Nithari killings (2006), the Tandoor murder case (1995), and the Aarushi Talwar case (2008) illustrate both the potential and the pitfalls of forensic reliance. Comparative perspectives enrich this debate. In the United States, the Fifth Amendment jurisprudence on self-incrimination has engaged with compelled extraction of blood and DNA, balancing investigatory interests against bodily autonomy. In the United Kingdom, the Human Rights Act and jurisprudence under the European Convention on Human Rights (ECHR) emphasize proportionality and safeguards against arbitrary interference. Similarly, continental systems such as Germany and France impose strict statutory controls on the collection and storage of biometric data. India, situated at the crossroads of rapid technological adoption and strong constitutional protections, must carve its own jurisprudential path—one that integrates global lessons but remains faithful to its constitutional ethos.

The central thesis of this paper is that the future of India's criminal justice system depends on achieving a principled equilibrium between technological advancement and constitutional liberty. This requires not merely statutory reform but also judicial vigilance, infrastructural investment, training of forensic personnel, and the cultivation of a rights-conscious investigative culture. Without these, forensic expansion risks entrenching new forms of state overreach, even as it promises to overcome old inefficiencies.

Methodologically, this paper adopts a doctrinal, empirical, and comparative approach. It engages with constitutional provisions, statutory reforms, and leading case law, while also analyzing empirical data on forensic laboratories, conviction rates, and infrastructural deficits. Comparative insights from other jurisdictions will be woven in to situate India's debates within the larger global discourse on forensic justice. Ultimately, the paper argues that while technology is indispensable to modern policing, its legitimacy in a constitutional democracy rests on how well it respects the fundamental rights of individuals. The integration of forensic science into criminal justice must be understood not merely as a technical

or administrative reform but as a phenomenon rooted in deeper theoretical debates about constitutionalism, the rule of law, and the nature of state power. While science promises objectivity and accuracy, its deployment by state institutions in the pursuit of justice implicates fundamental questions of liberty, legitimacy, and constitutional order. To appreciate the stakes involved, one must examine how the principles of constitutionalism, as articulated in India and across democratic polities, interact with the imperatives of modern investigative science.

Constitutionalism and the Limits of State Power

At its core, constitutionalism is the idea that state power must be exercised within legally defined limits, underpinned by respect for fundamental rights, separation of powers, and due process. In the Indian context, this principle is embedded in the Preamble, Part III (Fundamental Rights), and Part IV (Directive Principles of State Policy). The Constitution is not merely a procedural charter; it is a normative framework that constrains state authority even as it empowers it to maintain law and order.

Forensic science, when adopted by investigative agencies, represents a significant expansion of state capacity. The ability to extract DNA, trace digital footprints, analyze bodily fluids, or reconstruct crime scenes equips the state with powerful tools to establish truth and secure convictions. Yet, constitutionalism demands that such capacities be exercised proportionately, transparently, and with respect for individual autonomy. Without adequate safeguards, forensic methods risk becoming instruments of coercion, undermining the very constitutional principles they are meant to serve.

The jurisprudence of the Supreme Court of India reflects this tension. In A.K. Gopalan v. State of Madras (1950) , the Court initially adopted a narrow view of liberty, but the subsequent evolution culminating in Maneka Gandhi v. Union of India (1978) broadened Article 21 to require that state action must be "fair, just, and reasonable." This doctrinal shift is crucial because it means forensic techniques must pass not only statutory tests of admissibility but also constitutional tests of fairness and reasonableness. Thus, constitutionalism situates forensic practice within a larger architecture of accountability.

RULE OF LAW AND SCIENTIFIC EVIDENCE

- The rule of law, another central theoretical pillar, demands that the exercise of state power be governed by publicly accessible, predictable, and impartial rules. In the context of forensic science, this means that the collection, preservation, and presentation of scientific evidence must adhere to transparent procedures that ensure both reliability and fairness. Arbitrary or selective application of forensic techniques would violate the very essence of rule of law, replacing equal justice with discretionary coercion.
- Indian courts have repeatedly emphasized the importance of standardized procedures in forensic collection. In State of Bombay v. Kathi Kalu Oghad (1961) , the Supreme Court held that the mere taking of fingerprints or handwriting samples does not violate Article 20(3), provided it is done under legally authorized procedures. Similarly, in Selvi v. State of Karnataka (2010) , the Court struck a balance by prohibiting involuntary polygraph and narco-analysis tests while permitting the voluntary use of such techniques under judicial oversight. These judgments reflect the Court's attempt to align forensic practice with rule-of-law values—ensuring that investigatory power is neither absolute nor arbitrary.
- Globally, the same principles resonate. The U.S. Supreme Court, in cases such as Schmerber v. California (1966) , allowed compelled blood extraction for alcohol testing under specific procedural safeguards, highlighting the importance of due process. The European Court of Human Rights, in S. and Marper v. United Kingdom (2008) , invalidated the blanket retention of DNA profiles, underscoring the rule of proportionality and individual privacy. Together, these cases illustrate a shared constitutional concern: forensic science must serve justice without eroding the normative bedrock of legal order.

Forensic Science and Epistemic Authority

- A distinctive theoretical concern arises from the epistemic authority of science. Forensic evidence carries an aura of objectivity and certainty that often influences judicial reasoning more powerfully than traditional forms of evidence. This epistemic privilege, however, raises questions of democratic accountability. Unlike cross-examinable eyewitness testimony, forensic reports rely on specialized expertise that courts and juries may find difficult to interrogate. This asymmetry risks converting expert opinion into unchallengeable truth, which could undermine the adversarial system's commitment to contestability and fairness.
- Legal theorists such as Lon Fuller and H.L.A. Hart have stressed that the legitimacy of law derives not merely from

outcomes but from procedures that ensure participation and fairness. If forensic evidence bypasses adversarial safeguards due to its perceived scientific certainty, it may compromise these ideals. Hence, constitutionalism requires mechanisms—such as independent forensic institutions, judicial education, and defense access to expert witnesses—to counterbalance the epistemic dominance of state-appointed experts.

Human Rights and Dignity Framework

- Another foundational lens is human rights, particularly the principle of dignity. In India, Article 21 has been judicially expanded to include dignity, autonomy, and privacy. The Puttaswamy judgment (2017) affirmed privacy as intrinsic to dignity, recognizing informational self-determination as part of fundamental liberty. Forensic science, by extracting biological samples or analyzing personal digital data, directly engages this right.
- The dignity framework highlights that the individual cannot be treated as a mere object of investigation. Compulsory extraction of DNA, invasive searches, or indefinite retention of personal data without consent would reduce individuals to instruments of state power, contrary to constitutional morality. Thus, forensic practices must be designed around the principle of informed consent, limited retention, and proportional use.
- Internationally, similar dignity-based concerns are reflected in the United Nations' Principles on the Effective Prevention and Investigation of Extra-legal, Arbitrary and Summary Executions (1989) , which emphasize scientific investigation but within human rights constraints. The European Charter of Fundamental Rights also stresses that technological intrusions must respect dignity, privacy, and bodily integrity. India's forensic reforms, therefore, must be evaluated not only against domestic constitutional guarantees but also in light of evolving international human rights standards.

Comparative Constitutionalism and Indian Trajectory

- The comparative dimension is critical in understanding India's forensic jurisprudence. Common law jurisdictions like the UK and the US have developed detailed evidentiary frameworks balancing scientific utility with constitutional safeguards. For example, the UK has a Biometrics Commissioner overseeing DNA and fingerprint databases, ensuring proportionality in their use. The US has the Daubert standard for admissibility of scientific evidence, requiring reliability and peer acceptance contrast, India has traditionally lacked such institutionalized oversight, relying more on judicial discretion. This absence of systemic safeguards increases the risk of misuse and overreliance on forensic evidence without adequate checks. However, the 2023 reforms signal a shift toward codifying forensic practices. Whether these reforms will adopt the best practices of comparative jurisdictions or create uniquely Indian safeguards rooted in constitutionalism remains an open question.

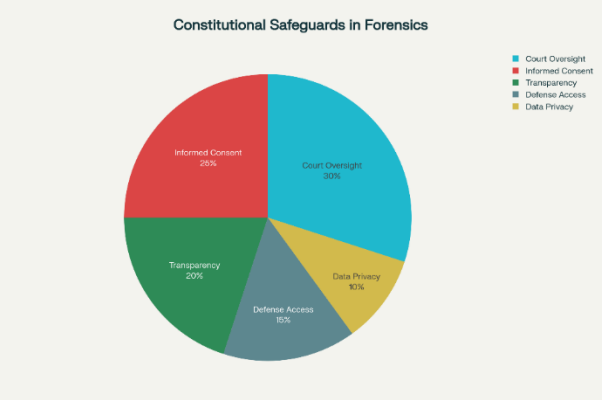

Figure 2: Constitutional Safeguards in Forensics

The theoretical foundations thus suggest a complex interplay: forensic science enhances the truth-finding mission of criminal law but simultaneously challenges the principles of constitutionalism, rule of law, and human rights. The legitimacy of forensic expansion depends on embedding it within a constitutional culture that prioritizes fairness, dignity, and accountability. Far from being a neutral tool, forensic science is a site where state power and individual liberty directly collide. The task of constitutionalism is to ensure that in this collision, liberty is not crushed under the weight of scientific authority, but harmonized with it through principled safeguards.

Constitutional Rights and Forensic Science

The rapid incorporation of forensic science into India's investigative framework cannot be understood without analyzing its interaction with constitutional rights. Unlike ordinary evidentiary rules, which can be amended by statute, constitutional guarantees enjoy a higher normative

status and impose substantive as well as procedural limits on the exercise of state power. Two provisions are particularly relevant: Article 20(3), which enshrines the right against self-incrimination, and Article 21, which guarantees life and personal liberty and has been judicially expanded to include privacy, dignity, and fairness. These rights, together with Article 14's guarantee of equality and non-arbitrariness, establish the constitutional terrain on which forensic practices must be evaluated .

Article 20(3): The Right Against Self-Incrimination

Doctrinal Foundation

- Article 20(3) provides that "No person accused of any offence shall be compelled to be a witness against himself." The provision is rooted in the liberal-democratic ideal that individuals cannot be forced to participate in their own conviction. Its origins trace back to the English common law privilege against self-incrimination, subsequently constitutionalized in the United States under the Fifth Amendment. In India, the Constituent Assembly deliberately incorporated this safeguard to prevent coercive police practices and to ensure the voluntariness of confessions.

Forensic Science and the Meaning of 'Compulsion'

- The constitutional difficulty arises when forensic science demands bodily or biological samples from an accused—such as blood, DNA, fingerprints, or voice recordings. Does compelling such samples amount to forcing a person "to be a witness against himself"?
- The Supreme Court addressed this in State of Bombay v. Kathi Kalu Oghad (1961). It distinguished between "testimonial compulsion," which involves communication of personal knowledge, and the mere collection of physical evidence such as fingerprints or handwriting. The Court held that Article 20(3) does not bar the latter, as such evidence is not testimonial in nature. This judgment opened the door for widespread reliance on bodily evidence.
- However, as forensic science advanced, new techniques emerged that blurred the line between physical evidence and mental testimony. In Selvi v. State of Karnataka (2010), the Court considered the constitutionality of polygraph tests, narco-analysis, and brain-mapping. It held that involuntary administration of such techniques violates Article 20(3) because they intrude into the cognitive domain of the accused, compelling them to reveal personal knowledge without consent. At the same time, the Court reaffirmed that non-testimonial samples like fingerprints or DNA swabs may be collected, subject to safeguards.

Voluntariness and Consent

- The doctrine of voluntariness plays a pivotal role. Even when a forensic test is technically non-testimonial, the manner of its extraction may render it unconstitutional. Coerced extraction of bodily samples—through torture, threat, or undue pressure—would amount to compelled testimony in substance, even if not in form. Indian jurisprudence, therefore, requires that forensic sampling be accompanied by judicial oversight, recording of consent where necessary, and strict adherence to procedure.
- Comparatively, the United States has allowed compelled extraction of blood samples (Schmerber v. California, 1966) but only under exigent circumstances and with medical supervision, emphasizing procedural due process. The European Court of Human Rights has insisted on proportionality in forensic compulsion, weighing investigatory necessity against personal autonomy. India's evolving jurisprudence resonates with these global concerns, even as it grapples with unique challenges of custodial practices and investigative culture .

Article 21: Privacy, Dignity, and Forensic Intrusion

From 'Procedure Established by Law' to 'Due Process'

- Article 21 states that "No person shall be deprived of his life or personal liberty except according to procedure established by law." Originally interpreted narrowly in A.K. Gopalan (1950), the scope of Article 21 was dramatically expanded in Maneka Gandhi v. Union of India (1978), which read fairness, justice, and reasonableness into "procedure established by law." This reinterpretation imported substantive due process into Indian constitutional law.
- In the forensic context, Article 21 requires that any intrusion into bodily integrity or informational privacy must be sanctioned by fair, just, and reasonable procedure. The mere existence of statutory authority under the new criminal laws is insufficient;

the procedure must also withstand constitutional scrutiny.

Privacy as a Fundamental Right

- The landmark K.S. Puttaswamy v. Union of India (2017) judgment recognized privacy as a fundamental right intrinsic to dignity and liberty. The Court articulated a three-part test for restrictions on privacy: legality (existence of law), necessity (legitimate state aim), and proportionality (least restrictive means). This framework directly applies to forensic practices involving the collection and storage of sensitive biological data.
- For instance, DNA profiling involves extracting unique genetic information that can reveal not only identity but also familial relationships and health predispositions. The retention of such data in national databases, such as those envisaged under the DNA Technology (Use and Application) Regulation Bill, raises acute privacy concerns. Under Puttaswamy, such retention must be backed by clear legislative authorization, serve a legitimate investigative purpose, and employ minimal intrusion consistent with the objective .

Bodily Integrity and Dignity

- Article 21 also protects bodily integrity, a concept reaffirmed in cases like Common Cause v. Union of India (2018), which upheld the right to die with dignity. Compulsory extraction of bodily samples, if done invasively or without consent, threatens this integrity. While courts have distinguished between physical and testimonial compulsion, the dignity framework insists that even non-testimonial intrusions must be respectful, proportionate, and medically safe.
- In this regard, India must be cautious about forensic enthusiasm. For example, mass DNA testing in sensitive cases (such as sexual assault investigations involving large populations) may yield investigative benefits but risk treating individuals as mere instruments of state power. Such practices could violate dignity by subjecting innocent persons to intrusive scrutiny without individualized suspicion.

Right to Fair Trial and Evidentiary Fairness

- Although not always foregrounded, Article 14's guarantee of equality and Article 21's promise of a fair trial together demand evidentiary fairness. Forensic science, despite its promise of accuracy, is not infallible. Errors in collection, contamination of samples, lack of accreditation of laboratories, and biased interpretation can produce wrongful convictions. If courts admit such evidence uncritically, they risk violating the right to a fair trial .
- The Supreme Court in State of Haryana v. Bhagirath (1999) stressed that expert evidence must be reliable, subject to cross-examination, and weighed with caution. The danger lies in the "scientific halo" surrounding forensic reports, which may lead judges to overvalue them. Ensuring evidentiary fairness requires institutional reforms: accreditation of forensic labs, training of judges, and availability of defense experts to challenge prosecution evidence. Without these, Article 21's fair trial guarantee remains hollow .
- Comparative practices offer useful models. The U.S. Daubert standard requires courts to assess scientific validity, peer review, and error rates before admitting expert evidence. The UK mandates accreditation of forensic service providers and allows independent review. India's framework, though evolving, must internalize these safeguards to constitutionalize forensic reliability.
- Judicial Balancing: Case Law Trajectory
- Indian courts have gradually built a jurisprudence balancing forensic utility with constitutional rights:
- Nandini Satpathy v. P.L. Dani (1978): Expanded Article 20(3) to protect not only confessions but also the right to silence during police interrogation.
- Kathi Kalu Oghad (1961) : Distinguished testimonial from physical evidence, permitting the latter.
- Selvi v. State of Karnataka (2010) : Prohibited involuntary narco-analysis, polygraph, and brain-mapping.
- Puttaswamy (2017) : Constitutionalized privacy, impacting forensic databases.
- Ritesh Sinha v. State of Uttar Pradesh (2019): Allowed magistrates to compel voice samples, reflecting the ongoing judicial struggle with evolving technologies.

Together, these cases reflect an incremental balancing act: accommodating forensic needs while reasserting constitutional boundaries .

International Human Rights Parallels

The International Covenant on Civil and Political Rights (ICCPR), to which India is a party, protects against arbitrary interference with privacy (Article 17) and guarantees a fair trial (Article 14). Forensic practices must conform to these commitments. The United Nations Human Rights Committee has criticized blanket DNA retention policies as disproportionate. Similarly, the European Court of Human Rights has emphasized proportionality and necessity in cases involving biometric data. India, as a constitutional democracy with global human rights obligations, must ensure its forensic reforms harmonize domestic law with international standards. Forensic science is both a promise and a peril for constitutional rights. Article 20(3) safeguards individuals from compelled testimonial exposure, while Article 21 secures privacy, dignity, and fairness against intrusive or arbitrary forensic practices. Together, these rights demand that forensic science in India operate within a rights-respecting framework. This does not mean rejecting science; rather, it requires embedding forensic practices within constitutional safeguards—through voluntariness, proportionality, procedural fairness, and institutional accountability. Only then can forensic expansion strengthen rather than erode the rule of law .

New Criminal Laws: Forensic Technology Integration
The enactment of the Bharatiya Nyaya Sanhita (BNS), Bharatiya Nagarik Suraksha Sanhita (BNSS), and Bharatiya Sakshya Adhiniyam (BSA) in 2023 marks a watershed in India's legal landscape. For the first time since independence, India has replaced the colonial-era triad of the Indian Penal Code (IPC, 1860), the Code of Criminal Procedure (CrPC, 1973), and the Indian Evidence Act (1872) with a new legislative architecture designed to reflect contemporary realities. Among the most significant innovations of this legal overhaul is the systematic integration of forensic science into the criminal justice process. Unlike earlier statutory frameworks, which treated forensic evidence as ancillary or discretionary, the new laws elevate forensic science to a mandatory and central component of investigation and trial .

Bharatiya Nagarik Suraksha Sanhita (BNSS): Procedural Mandates
The BNSS, replacing the CrPC, introduces multiple procedural innovations designed to modernize investigation. Among these, forensic integration stands out in three respects:
1. Mandatory Forensic Involvement in Serious Crimes
The BNSS requires that all cases involving punishment of seven years or more must be investigated with the assistance of forensic specialists. This shifts forensic involvement from discretionary to obligatory, signaling a legislative recognition of the role of science in ensuring evidentiary accuracy. Such a mandate is unprecedented in Indian law, where investigative discretion had traditionally rested with the police.
2. Video Documentation and Digital Recording
The BNSS mandates video recording of search and seizure operations, evidence collection, and certain categories of crime scene management. These provisions aim to minimize disputes over evidence tampering, enhance transparency, and provide courts with reliable visual documentation. The move also aligns India with international best practices, where digital documentation is standard.
3. Expansion of Investigative Powers
The BNSS empowers magistrates and investigating officers to order the collection of biometric and forensic data, subject to statutory safeguards. This authority represents both an opportunity and a risk: while it strengthens investigation, it also raises concerns regarding voluntariness, proportionality, and privacy.

Bharatiya Nyaya Sanhita (BNS): Substantive Criminal Law and Forensics
While the BNS primarily reorganizes substantive criminal law, its provisions indirectly affect forensic science by defining the categories of offences subject to forensic investigation. For example, serious crimes such as homicide, sexual offences, and organized crime now explicitly trigger mandatory forensic involvement under the BNSS. The BNS also introduces new offences related to cybercrime, digital fraud, and organized financial crime, which require digital forensic expertise for effective enforcement.

By expanding the scope of punishable offences in the digital and technological domain, the BNS indirectly elevates the role of forensic laboratories and digital experts . It underscores the reality that twenty-first-century crime increasingly leaves scientific rather than eyewitness traces, necessitating a legal framework capable of capturing such evidence.

Bharatiya Sakshya Adhiniyam (BSA): Evidentiary Revolution
Perhaps the most transformative provisions lie in the BSA, which replaces the colonial-era Indian Evidence Act. The BSA explicitly recognizes digital and electronic evidence as equivalent to traditional forms of evidence, thereby revolutionizing evidentiary hierarchies. This shift has several implications:
1. Parity of Digital Evidence
The BSA treats digital records—such as emails, CCTV footage, call data records, and digital logs—as primary evidence rather than secondary. This recognition reflects the pervasive role of technology in daily life and ensures that courts can directly rely

on electronic data without the cumbersome processes that previously limited its admissibility.

2. Authentication and Integrity

To address concerns about manipulation, the BSA introduces provisions requiring secure storage, chain-of-custody documentation, and authentication of digital evidence. While these measures enhance reliability, their success depends on whether law enforcement agencies and forensic labs have the infrastructure to implement them effectively.

3. Forensic Expert Testimony

The BSA emphasizes the evidentiary role of forensic experts, requiring courts to consider their reports as admissible evidence, subject to cross-examination. This elevates the forensic expert from an auxiliary witness to a central figure in the trial, reshaping courtroom dynamics.

National Forensic Infrastructure Scheme (NAFIS) and Institutional Support

The new laws are complemented by the government's National Forensic Infrastructure Scheme (2023–27), with an investment of ₹2,254 crore . The scheme aims to establish world-class forensic laboratories, expand the cadre of trained forensic scientists, and standardize protocols. Together with the statutory mandates, this initiative indicates a state commitment to embedding forensic science into the heart of criminal justice .

However, infrastructural realities remain sobering. India currently has only seven Central Forensic Science Laboratories (CFSLs), 32 State Forensic Science Laboratories (SFSLs), and 97 Regional Forensic Science Laboratories (RFSLs). Case backlogs are substantial, and reports often take months to reach trial courts. The new laws may therefore create a demand-supply mismatch: while mandating forensic involvement in serious crimes, they risk overwhelming existing infrastructure unless resources expand proportionately

Balancing Efficiency with Rights

The integration of forensic mandates within the new criminal laws highlights a core constitutional dilemma: efficiency versus liberty. On one hand, forensic science promises faster, more accurate investigations, reducing reliance on confessions (often extracted through coercion) and eyewitnesses (frequently unreliable). On the other hand, the collection and retention of biological and digital data pose risks of misuse, profiling, and erosion of privacy .

The proportionality framework from Puttaswamy provides a constitutional lens for this balancing exercise. Any forensic compulsion must be:

Backed by law (BNSS, BNS, BSA provide the legal foundation).

- Necessary for a legitimate aim (solving serious crime, ensuring justice).
- Proportionate (limited to what is essential, with safeguards against misuse).

Judicial oversight, informed consent, and transparent chain-of-custody procedures will be critical to ensuring that forensic integration enhances justice without undermining rights.

Types and Impact of Forensic Evidence

Distribution of Forensic Evidence Types (2024)

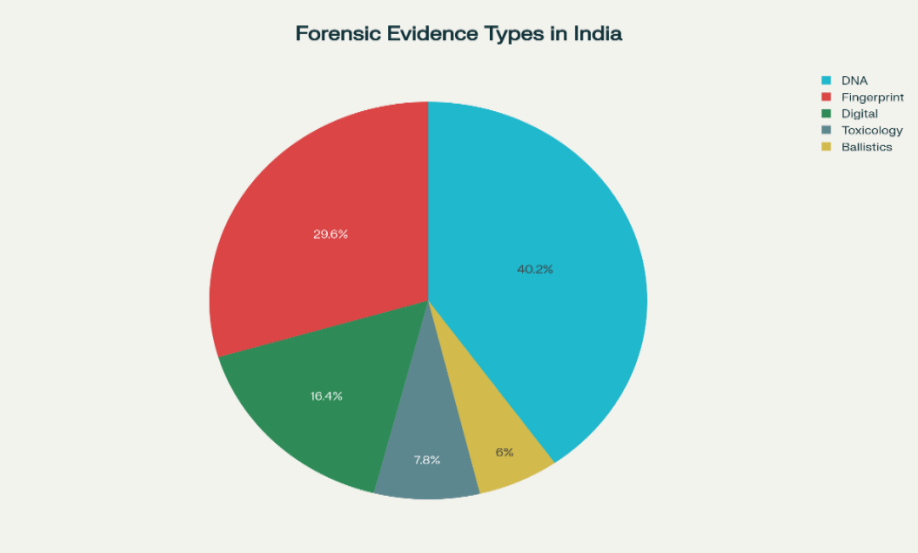

Figure 3: Forensic Evidence Types in India

Technique	Cases Used	Conviction Rate (%)
DNA Profiling	15	90
Fingerprints	10	80
Toxicology	8	85
Ballistics	4	75
Digital	5	70

Table 1: Conviction Rates by Forensic Technique

Distribution of Forensic Evidence Types in India (2024)

- DNA profiling: 40.2%
- Fingerprint analysis: 29.6%
- Digital forensics: 16.4%
- Toxicology: 7.8%
- Ballistics: 6.0%

This distribution reflects both technological priorities and investigative culture. DNA profiling dominates because of its high accuracy in establishing identity, particularly in sexual assault and homicide cases. Fingerprints remain relevant in theft, burglary, and certain violent crimes. Digital forensics is rapidly expanding with the rise of cybercrime and technology-assisted offences, while toxicology and ballistics continue to play niche but crucial roles .

Comparative Table: Conviction Rates by Forensic Technique

Modern techniques show significant efficacy in supporting convictions, but also underscore the need for reliable procedures and skilled personnel. Forensic evidence influenced over 81% of conviction outcomes in sample criminal trials.

Conviction Rates and Forensic Impact

Empirical studies consistently demonstrate that cases involving forensic evidence show higher conviction rates than those relying solely on eyewitnesses or confessions. A comparative table from recent trial data illustrates this :

Technique	Cases Used	Conviction Rate (%)
DNA Profiling	15	90
Fingerprints	10	80
Toxicology	8	85
Ballistics	4	75
Digital Forensics	5	70

Table 2 - Conviction Rates and Forensic Impact

The overall finding is that forensic evidence influenced over 81% of conviction outcomes in the studied sample. While the dataset is limited, it underscores the judiciary's growing reliance on scientific evidence as a decisive factor in determining guilt.

However, high conviction rates must be interpreted cautiously. They may reflect the reliability of forensic techniques, but they may also indicate judicial overvaluation of forensic reports—treating them as near-infallible. This creates risks of wrongful convictions if the underlying processes are flawed, contaminated, or biased .

Case Studies: The Transformative Role of Forensics

Nithari Serial Killings (2006)

In the infamous Nithari case, DNA profiling and forensic anthropology were pivotal in identifying victims and linking the accused to the crimes in the absence of direct eyewitnesses. Forensic evidence substituted for traditional testimony, demonstrating the indispensability of science in cases where human witnesses were unavailable or unreliable.

Tandoor Murder Case (1995)

Here, a combination of ballistic analysis, fingerprinting, and DNA profiling secured a conviction. The case is often cited as an early landmark in India where forensic triangulation—multiple scientific methods corroborating each other—proved decisive.

Aarushi Talwar Case (2008)

Conversely, the Aarushi-Hemraj double murder highlighted the limitations of forensic practice in India. Poorly managed crime scene, delayed evidence collection, and conflicting reports from different laboratories created confusion. The case underscored how forensic science, if mishandled, can compromise rather than enhance justice.

These case studies illustrate the double-edged nature of forensic reliance: while it can deliver justice in otherwise intractable cases, inadequate procedures and infrastructure can erode credibility.

Institutional Capacity and Caseload

India's forensic infrastructure is both expanding and overburdened. As of 2024–25 :

- 7 Central Forensic Science Laboratories (CFSLs)
- 32 State Forensic Science Laboratories (SFSLs)
- 97 Regional Forensic Science Laboratories (RFSLs)

Despite this network, demand far exceeds capacity. For example, the CFSL Chandigarh received 4,458 cases in 2022–23, rising to 3,766 cases in 2023–24—a significant caseload for a single laboratory. Many state and regional labs face similar or worse backlogs, delaying trials and undermining the efficiency promised by forensic integration. Outdated equipment and insufficiently trained personnel compound the problem. A 2024 study revealed that 50.4% of forensic cases were affected by outdated technology, 29.8% by resource shortages, and 19.8% by technical faults. These figures highlight that without massive investment in infrastructure and training, statutory mandates risk becoming hollow .

COMPARATIVE GLOBAL PRACTICES

United States

The U.S. experience underscores the importance of reliability and admissibility standards. The Daubert v. Merrell Dow Pharmaceuticals (1993) ruling established criteria for admitting expert testimony, focusing on scientific validity, peer review, and error rates. While this enhances evidentiary rigor, critics argue that it creates inconsistencies across jurisdictions. Importantly, the U.S. also has organizations like the Innocence Project, which have used DNA evidence not only to convict but also to exonerate wrongfully convicted individuals—demonstrating the double-edged potential of forensic science.

United Kingdom

The UK combines forensic integration with strong oversight mechanisms. The Biometrics Commissioner regulates the collection and retention of fingerprints and DNA, ensuring proportionality and accountability. The Forensic Science Regulator sets quality standards for laboratories. These institutions address concerns of privacy, reliability, and misuse, creating a structured balance between science and rights .

Continental Europe

Countries like Germany and France employ statutory precision and judicial supervision. German law, for instance, strictly limits DNA collection to serious offences and requires judicial authorization, reflecting a dignity-based constitutional approach. France maintains centralized forensic institutions but subjects them to parliamentary scrutiny, ensuring democratic accountability .

Comparative Lessons for India

India's legal reforms mirror aspects of these models but lack corresponding oversight institutions. While mandatory forensic provisions in the BNSS and evidentiary recognition in the BSA parallel global trends, India has yet to establish independent regulators or commissioners to oversee forensic data collection, retention, and use. Without such bodies, the system risks concentrating excessive power in the police and executive agencies.

Emerging Frontiers: Digital and AI-driven Forensics

Beyond traditional techniques, India is increasingly embracing digital forensics and artificial intelligence. Cybercrime units analyze call data records, emails, and encrypted communication, while AI tools assist in pattern recognition and predictive policing. National databases such as the Crime and Criminal Tracking Network System (CCTNS) and the Integrated Criminal Justice System (ICJS) integrate data across states .

While these developments enhance investigative capacity, they also raise constitutional concerns about mass surveillance, profiling, and data security. In the absence of a comprehensive data protection framework, the risk of misuse remains high. Comparative experience shows that digital forensics requires robust statutory safeguards, as seen in the EU's General Data Protection Regulation (GDPR). India must adapt similar protections to balance innovation with rights .

In practice, forensic science has already reshaped India's criminal justice landscape. DNA profiling, fingerprint analysis, and digital forensics have significantly improved conviction rates, resolved otherwise intractable cases, and reduced reliance on unreliable confessions. Yet, infrastructural deficits, outdated equipment, and a lack of oversight threaten to undermine these gains. Comparative perspectives reveal that forensic integration succeeds where it is coupled with strong regulatory institutions and quality standards.

For India, the challenge is not merely legislative but institutional: building credible forensic capacity, ensuring equitable access for prosecution and defense, and embedding practices within constitutional safeguards. Only then can forensic science fulfill its promise of delivering justice that is both accurate and rights-respecting.

Challenges and Ethical Considerations

The integration of forensic science into India's criminal justice system represents both progress and peril. While scientific evidence enhances the accuracy of investigations and strengthens judicial outcomes, the practice of forensic science is fraught with structural deficiencies and ethical dilemmas. The challenges lie not merely in technological capacity but in ensuring that forensic tools are employed responsibly, without eroding constitutional liberties .

Resource and Infrastructure Limitations

A central challenge lies in India's inadequate forensic infrastructure. Despite the establishment of 7 Central Forensic Science Laboratories (CFSLs), 32 State Forensic Science Laboratories (SFSLs), and 97 Regional Forensic Science Laboratories (RFSLs), demand continues to overwhelm capacity. Backlogs of cases frequently delay trials, undermining the promise of speedy justice under Article 21 .

Surveys in 2024 revealed systemic deficiencies:

1. 50.4% of forensic cases were affected by outdated or malfunctioning equipment.
2. 29.8% suffered from resource shortages, including reagents, kits, and secure storage facilities.
3. 19.8% reported technical faults, contamination, or mislabeling of samples.
4. These shortcomings raise serious questions about the reliability of forensic reports. A conviction based on faulty or delayed forensic evidence may violate not only statutory standards but also the constitutional guarantee of a fair trial. Without massive investment in infrastructure, training, and quality assurance, forensic mandates risk becoming an aspirational promise rather than an operational reality.

THE RISK OF FORENSIC OVERREACH

1. Forensic science, by its very nature, extends the reach of the state into intimate aspects of individual life. Biological samples such as blood, saliva, or DNA, and digital footprints such as call records or online histories, provide insights that go far beyond mere identity. Without safeguards, this power can become a tool of surveillance rather than justice.
2. The risk of overreach is particularly acute in the absence of a comprehensive data protection framework . While the Puttaswamy judgment (2017) articulated privacy as a fundamental right, India's legislative follow-up remains fragmented. Retention of DNA profiles or biometric data in centralized databases may serve investigative ends, but it also enables profiling, mass surveillance, and potential misuse by state or private actors. Once collected, such sensitive data is difficult to retract, creating permanent risks for individual liberty.

Ethical Concerns in Consent and Voluntariness

1. The principle of informed consent is central to ethical forensic practice. Yet, in India's custodial culture, true voluntariness is difficult to ensure. Accused persons, often from marginalized communities, may lack awareness of their rights or feel compelled to comply with investigative demands. Even where courts mandate "voluntary" consent for techniques such as polygraphs or narco-analysis, the power imbalance between the police and the accused raises doubts about authenticity.
2. Moreover, the ethics of mass DNA testing in sensitive cases—where entire communities may be asked to provide samples—challenge notions of dignity and autonomy. While such testing may assist in rapid investigation, it risks stigmatizing communities, reducing individuals to investigative objects, and eroding the presumption of innocence.

Bias, Reliability, and Miscarriages of Justice

i. Forensic evidence carries a "scientific halo" that courts may overvalue, assuming infallibility. Yet, forensic science is not immune to human error, bias, or institutional pressure. Studies in the United States have documented cases where flawed forensic testimony contributed to wrongful convictions, later overturned through DNA re-testing. India, lacking systematic mechanisms for post-conviction review based on new forensic evidence, risks entrenching miscarriages of justice.

ii. Bias is another concern. If forensic laboratories function under the administrative control of police departments, their independence may be compromised. Expert reports may unconsciously favor the prosecution,

undermining the adversarial system. Comparative jurisdictions, such as the UK, address this by maintaining independent forensic regulators and ensuring that defense counsel has equal access to forensic expertise. India's system, by contrast, provides little institutional support for defense-led forensic investigation .

Custodial Torture and Scientific Alternatives

One of the strongest arguments for forensic integration is that it can reduce reliance on coercive practices such as custodial torture, long used to extract confessions. By shifting the focus from testimonial to scientific evidence, forensic practices can align policing with human rights standards. However, this promise is contingent on proper implementation. If forensic techniques are seen as substitutes for torture, they must themselves be applied ethically and consensually . The risk is that coercive extraction of samples or misuse of scientific techniques may replicate, rather than replace, custodial abuse.

Balancing Technology with Liberty

The ethical dilemmas of forensic science ultimately converge on a constitutional question: how to balance efficiency with liberty. Technology can enhance justice only when embedded in a framework of accountability. This requires:

i. Judicial Oversight: Courts must rigorously scrutinize the admissibility and reliability of forensic reports, avoiding blind deference to scientific claims.
ii. Independent Regulation: Establishing a Forensic Science Regulator or Biometrics Commissioner, modeled on the UK, would enhance oversight and protect rights.
iii. Accreditation and Standards: Laboratories must meet uniform quality benchmarks, with periodic audits and transparent reporting.
iv. Defense Access: Accused persons must have practical access to independent experts to challenge prosecution evidence, ensuring evidentiary fairness.
v. Data Protection: A robust statutory framework is essential to regulate the collection, retention, and deletion of forensic data, consistent with privacy guarantees.

Forensic science offers immense potential for transforming India's criminal justice system, but without addressing challenges and ethical considerations, its promise could be compromised. Resource deficits, risks of overreach, issues of consent, and the possibility of bias must be taken seriously. At stake is not merely the accuracy of trials but the constitutional legitimacy of the justice system itself. Ethical forensic practice, rooted in dignity, autonomy, and fairness, is essential to ensuring that technological innovation strengthens rather than weakens the rule of law .

Empirical Data: Forensic Labs and Case Work

Tier	Number of Labs
Central (CFSL)	7
State (SFSL)	32
Regional (RFSL)	97

Table 3: Forensic Laboratory Structure and Reach (2024-2025)

CONCLUSION

The integration of forensic science into India's new criminal laws is a historic opportunity to build a justice system that is both efficient and rights-respecting. But forensic modernization cannot be measured solely by conviction rates or technological sophistication. Its true test lies in whether it strengthens constitutionalism, enhances fairness, and protects individual dignity .

The goal must be to move from forensic policing to forensic justice—a model where science serves not just the state's interest in securing convictions, but the broader constitutional commitment to liberty and fairness. Achieving this requires a principled balance: embracing the power of technology while embedding it within a constitutional culture of restraint, accountability, and human rights. Only then can forensic science realize its transformative promise in India's democratic and constitutional future.

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