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BRIDGING SCIENCE AND JUSTICE: FORENSIC EVIDENCE, CRIMINAL INVESTIGATION, AND CONSTITUTIONAL SAFEGUARDS IN INDIA

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ABSTRACT

Forensic science is a unique place where the law and the natural sciences meet, giving investigators an objective vocabulary to reconstruct events that might otherwise rely on the fallible memory of witnesses. The article examines the role of forensic evidence in the Indian criminal justice system, tracing its historical evolution from colonial anthropometry to modern DNA profiling, digital forensics, and algorithsmic pattern recognition. This scientific apparatus is located within the statutory scheme surrounding the Indian Evidence Act, 1872 and the Code of Criminal Procedure, 1973 and their recent replacements, before turning to the constitutional friction that the use of such evidence often generates, especially under Article 20(3) and Article 21. Using the landmark rulings such as Selvi v. State of Karnataka, Puttaswamy v. Union of India and State of Bombay v. Kathi Kalu Oghad, the article argues that Indian courts have generally succeeded in drawing a line between testimonial compulsion and mere physical extraction of bodily samples, even as the infrastructure for reliable forensic reports remains uneven. A comparative look at the regulatory frameworks in the United Kingdom and the United States – the Forensic Science Regulator model and the Daubert standard respectively – is used to identify workable reforms for India including a dedicated accreditation authority, uniform admissibility criteria, and stronger privacy safeguards for genetic data. The article concludes that forensic science can only be relied upon for justice where legislative standardisation, judicial vigilance and constitutional fidelity function together, rather than as isolated compartments of the criminal process.

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Keywords: Forensic evidence, criminal investigation, Article 20(3), right to privacy, DNA profiling, admissibility, Indian Evidence Act, comparative criminal justice.

I. INTRODUCTION

At its core, every criminal trial is an exercise in reconstructing the past from fragments of the present—a bloodstain, a fingerprint, a deleted file, a strand of hair. Forensic science is the way those fragments are turned into facts a court can rely upon. The word "forensic" derives from the Latin forensis, meaning "of the public forum," where once disputes were argued, and the discipline it names now combines biology, chemistry, physics, and computer science in the service of one legal question: what happened, and who is responsible for it. Its value is precisely in its claim to objectivity. A validated forensic finding doesn't change its story on cross-examination, unlike eyewitness testimony, which is notoriously susceptible to suggestion, stress and the ordinary frailties of human memory. But the promise of scientific certainty has always been somewhat at odds with the practical conditions under which forensic work is actually done. A DNA match is only as reliable as the lab that produced it; a fingerprint comparison is only as good as the examiner who did it; a digital forensic report is only as good as the chain of custody that maintained the underlying device. In India, this tension is further complicated by resource constraints, an uneven accreditation regime, and a body of constitutional doctrine that must determine when the state's interest in solving crime gives way to the individual's interest in bodily and informational autonomy. This is an exploration of this terrain. The next part follows the journey of development of the methods used in forensics, which ranges from the anthropological records during the colonial period to the current use of genomic and digital forensics. Next, the third part discusses the statutes that form the framework within which the law operates as regards the submission of expert evidence in criminal cases, the primary statutes being the Indian Evidence Act, 1872 and Code of Criminal Procedure, 1973, and their 2023 counterparts. The fourth part then delves into the constitutional jurisprudence, particularly the right against self-incrimination and the right to privacy. The fifth part examines the approach by the court to forensic evidence through certain landmark judgments. The sixth part then outlines the obstacles that remain inherent in the field, and finally, the seventh part compares the Indian approach to the regulation of this area in the UK and US jurisdictions.

ISSN: 2582-6433

II. FORENSIC SCIENCE: EVOLUTION AND CONTEMPORARY TECHNIQUE

A. Historical Trajectory

Forensic methodology was not a ready-made system, but emerged gradually through the process of adopting various laboratory techniques and applying them to legal proof. In nineteenth century Europe, there were two important identification methods devised by two prominent figures: the anthropometric method invented by Alphonse Bertillon and the classification of fingerprints created by Sir Francis Galton, which both attempted to address the same issue — identifying offenders who committed multiple crimes. The anthropometric technique was introduced to India by the British administration, and the Calcutta Anthropometric Bureau founded in 1878 can be considered one of the first organizations engaged in forensic methodology in India. Since the fingerprint method provided better results and was more convenient than the anthropometric one, it was preferred in India.

The forensic setup in independent India was formed over time, using the Central Forensic Science Laboratory in Kolkata, which was created in 1952, as the model for a chain of State Forensic Science Laboratories which are in place presently, albeit with some inconsistencies. The rate of development speeded up quite a bit in the past three decades with the introduction of DNA identification techniques, as well as in the last two decades with digital forensics in the wake of computer crimes.

B. Contemporary Techniques

Forensic science can be better defined as a set of specialized scientific practices rather than one scientific process. The DNA fingerprinting technique is still the most significant one in the set, since no other piece of physical evidence has the power to associate a person with a crime scene, or exclude an innocent person from the investigation. Fingerprint and pattern evidence analysis works in a complementary fashion, especially in the context of property crimes, but it is more dependent on the interpretation of examiners. Ballistics and tool mark analysis connect weapons and other instruments used for a crime with the inflicted injury. Forensic toxicology determines the presence and levels of drugs, poisons, and alcohol in biological specimens, and plays a crucial role when there is a suspicion of poisoning and drunk driving. Forensic accounting is increasingly becoming important in light of the increase in economic crimes. For its part, digital forensics is all but indispensable today, inasmuch as it restores deleted files, recreates web activity logs, and verifies electronic communication in a legal system where a

ISSN: 2582-6433

considerable amount of criminal behavior, and a considerable amount of evidence exonerating suspects, takes place at a computer screen and not at a crime scene.

Yet further evolution in new methodologies is occurring. Next-generation sequencing enables the analysis of biological samples which cannot be analyzed by previous techniques and has been useful in resuscitating cold cases. Machine learning is being applied more and more often to large datasets of digital and financial records to uncover inconsistencies which may go unnoticed by humans, even though machine outputs have to be interpreted by experts before being used as evidence. High-definition photography, three-dimensional scanning, and photography from drones enable crime scenes to be photographed in a manner that preserves information which cannot be recorded using conventional techniques. All of these developments increase the scope of forensic science, while posing a parallel set of issues regarding reliability, bias, and appropriate limits of automation, which Part VI will address.

III. THE LEGISLATIVE FRAMEWORK GOVERNING FORENSIC EVIDENCE IN INDIA

A. The Indian Evidence Act, 1872

The core statutory framework under which expert evidence is received in India has historically been Section 45 of Part II of the Indian Evidence Act, 1872, which has been largely reenacted in the Bhartiya Sakshya Adhiniyam, 2023. Section 45 enables the court to receive the opinion of any person skilled in a particular science, art or profession in regard to matters relating to such science or art whenever they are of such a nature that it is desirable for the ascertainment of the truth of such matters that a person having special skill should give an opinion thereon, and the point to be decided is one that relates to such science, art or profession. Section 45A was introduced through amendment in 2002, providing for opinions based on the analysis of electronic evidence. Section 46 sets out cases where facts otherwise irrelevant become relevant due to their being consistent or inconsistent with an expert opinion, and Section 47 is specific to opinions regarding handwriting, and Section 51 relates to the considerations governing the grounds for an expert opinion.

The Indian courts have always considered expert opinions to be persuasive and never decisive. In the case of Abdul Razak vs. State of Maharashtra, the Supreme Court agreed to take into consideration the relevance of the evidence based on a dog tracking test, but refused to give equal weight to such evidence as the opinion of a scientific expert on the basis of blood or chemical tests, since the conduct of an animal, in contrast to chemical reaction, is an

ISSN: 2582-6433

unpredictable factor involving judgement. Likewise, in Gobardhan vs. State, the court ruled that the mere claim by an excise officer that the fluid was illegal liquor would not do without the facts justifying such an opinion.

B. The Code of Criminal Procedure, 1973 and its Successor

The corresponding procedural law to the Evidence Act is the Code of Criminal Procedure, 1973, which has been largely superseded by the Bharatiya Nagarik Suraksha Sanhita, 2023. While the provision for the use of report by government scientific expert as evidence in absence of his or her presence in court except when report itself is challenged is contained in Section 293 of the old Code (which has been substantially reproduced as Section 329 of the new Sanhita), the judgement of Allahabad High Court in Jose Luis Quintanilla Sacristan v. State of U.P. established the principle that even the Director of a State Forensic Science Laboratory may not have to appear before the court merely to get such report accepted as evidence. The medical examination of the accused may be ordered under Sections 53 and 53A of the old Code (and Section 164A of the new Sanhita) on the request of investigating officers in case of sexual offences.

C. Special Statutes

In addition to the above general legislations, there are also certain special legislations which rely largely on forensic methodology. The Narcotic Drugs and Psychotropic Substances Act, 1985 states that the analysis of the seized drug forms an essential part in proving the commission of an offense, as per the decision in Vinay Kumar v. State of Haryana from the Punjab & Haryana High Court. There is also the pending DNA Technology (Use and Application) Regulation Bill 2019, which proposes to establish a DNA Profiling Board and lay down the regulation regarding the collection, preservation, and application of DNA in civil and criminal proceedings. It is worth noting how repeatedly this legislation has been deferred and is therefore telling in itself regarding the difficulty of balancing the investigative potential of a DNA database with the privacy issues it poses.

IV. CONSTITUTIONAL DIMENSIONS OF FORENSIC EVIDENCE

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

Clause 20(3) of the Constitution of India declares that "No person accused of any offense shall be compelled to be a witness against himself." The clause is an incorporation of the rule nemo tenetur seipsum accusare that is a part of common law jurisprudence. The clause guards against

ISSN: 2582-6433

the possibility of compelled testimonial communication but its applicability to forensic process has been a point of judicial concern as a large number of forensic evidence is physical in nature and is not communicative at all.

The leading case in this regard is State of Bombay vs. Kathi Kalu Oghad where an eleven-judge bench has observed that compelling the accused to give his fingerprints, handwriting samples or blood samples for purpose of comparison cannot amount to making him a witness against himself as the samples are merely used for identification or comparison and does not communicate personal knowledge about a fact by the accused. This ratio has further been affirmed in a recent decision of Ritesh Sinha vs. State of Uttar Pradesh.

The difference lies in the case of the procedure used which claims to retrieve information from the accused's mind rather than from the body. Narcoanalysis, polygraph tests and brain electrical activity tests conducted on the accused without his/her free and informed consent were said to be testimonial compulsions, and hence violative of Article 20(3) and the right to personal liberty enshrined in Article 21. The Court did not prohibit these procedures, but allowed their use only in cases of free and informed consent, and even so, the statement was restricted to being a mere investigative aid only. Selvi stands as the best exposition of the dividing line in Indian law between body as the source of physical evidence and mind as the source of testimonial evidence.

B. Article 21: Privacy and the Collection of DNA

Since Maneka Gandhi v. Union of India, the right to life and personal liberty under Article 21 has been understood to include a set of unenumerated rights, and the nine-judge bench judgment of Justice K.S. Puttaswamy v. Union of India recognized the right to privacy to be among them, but not more than what can be legally, rationally, and proportionately restricted. While Puttaswamy concerned itself with the constitutional validity of a statutory scheme of biometric identification, the proportionality principle laid down in it now constitutes the natural touchstone for analyzing the compulsory collection, retention, and use of forensic (genetic) material by the state.

This contradiction can also be observed from the way courts have approached DNA evidence in the first place. In Krishan Kumar Malik v. State of Haryana, the Supreme Court has ruled that DNA evidence will qualify as admissible and probative evidence in cases of sexual assaults, provided it is collected and analyzed according to the proper procedure, but in Gautam Kundu v. State of West Bengal, the court emphasized that the direction to a suspect to undertake a DNA test should not come easily because of the need to safeguard his personal autonomy.

ISSN: 2582-6433

And here is where the DNA Technology Regulation Bill comes in – its advocates see a nation-wide DNA database as something that would have the same value as the ones used in the UK and America, but the opposition argues that there is no provision in the draft bill for the protection from misuse of the genetic material of someone who has not been convicted of a crime.

C. Due Process and the Right to a Fair Trial

A third constitutional principle relating to the use of forensic evidence relates to the inherent fairness of the process itself once the evidence has been brought before the court. The right to legal representation is guaranteed by Article 22, while Section 313 of the old Code (retained in the Sanhita) allows the defendant a chance to answer the case against him, including the forensic evidence that has been collected against him. It must always be remembered that regardless of how scientifically sound the evidence is, it does not take away from the fundamental rule that the guilt of the accused must be proved beyond a reasonable doubt. As held in the famous case of Sharad Birdhichand Sarda v. State of Maharashtra, there are certain classical criteria for accepting circumstantial evidence including scientific evidence which include the fact that the chain of proof should be complete and consistent only with guilt. This point has been made more relevant in the case of Surendra Koli v. State of Uttar Pradesh, where the improper handling of the physical evidence in the investigation of the Nithari case has been considered.

V. JUDICIAL TREATMENT OF FORENSIC EVIDENCE: SELECTED ILLUSTRATIONS

A number of useful examples exist in the Indian case law regarding the use and evaluation of forensic evidence in practice. Thus, in the Tandoor murder case related to the death of Naina Sahni in Delhi in 1995, the blood group testing of the sample obtained from the crime site and blood groups of the victim's parents helped identify the person, which may be regarded as one of the first cases when forensic serology played an important role in an Indian court case. Twenty years later, the identification of the victim in the Sheena Bora case depended upon the DNA testing done years after the crime, which shows not only the longevity of genetic evidence but also the disturbing delay which may happen between committing a crime and solving it forensically. Moreover, in the Nitish Katara case reviewed by the Delhi High Court in Vishal Yadav v. State of Uttar Pradesh, the DNA test of the damaged samples against samples from

ISSN: 2582-6433

the deceased's parents became crucial due to the impossibility of traditional identification – visual and fingerprints'.

Evidence relating to fingerprints and patterns has earned a similar conditional approval. As per Maqbool Sheikh v. State of Maharashtra, the Supreme Court approved fingerprint evidence collected by authorised persons, provided that all procedural precautions are met, whereas as per Charan Singh v. State of Punjab, the Supreme Court warned against taking any fingerprint evidence in isolation and insisted on corroborating evidence from other sources. Similarly, the Supreme Court advised against giving blind belief to handwriting evidence: in Punjab National Bank v. Mercantile Bank of India, it instructed that handwriting evidence is not always infallible and in S. Gopal Reddy v. State of Andhra Pradesh reiterated its warning about handwriting evidence being fallible. Lastly, as regards electronic evidence, it has its own peculiar rule of admissibility. As per Anvar P.V. v. P.K. Basheer and further clarified in Arjun Panditrao Khotkar v. Kailash Kushanrao Gorantyal, any electronic record needs to be backed up by a certificate under Section 65B of the Evidence Act (Section 63 of the Bhartiya Sakshya Adhiniyam). In sum, these cases indicate a judiciary that is receptive to the use of forensic science to assist in proving facts, but wary of the implication that scientific evidence takes the place of the usual rules of proof and cross-examination.

VI. PERSISTENT CHALLENGES

In spite of the doctrinal maturity, however, the actual delivery of forensic science in India continues to fall short of the expectations of the law. There are some persistent problems that require particular attention here.

Difference in infrastructure- In different State Forensic Science Laboratories there are different levels of equipment, staffing and delay, and thus the reliability of a forensic report may as well depend on the state where a crime took place rather than on the science itself.

Lack of professionals- The shortage of trained forensic examiners always exceeds the demand for them.

Backlog of cases- There are sometimes backlogs in the number of samples to be examined in laboratories, which delays trials as pointed out by the Supreme Court in the case of Ram Singh v. State of Rajasthan and contradicts the constitutional principle of "justice delayed is justice denied" stated in the case of Maneka Gandhi.

Lack of common accreditation standards- It is still not obligatory to get accreditation by the National Accreditation Board for Testing and Calibration Laboratories in India, which leaves a possibility of methodology inconsistency among labs conducting similar tests.

ISSN: 2582-6433

Chain of custody issues Like the Nithari case has shown, as well as Vikram Singh v. State of Punjab has proved as a legal matter, inadequate sample handling documentation might make all forensic evidence questionable.

Poor collaboration among different branches of expertise- Investigator, forensic scientist, medic, judge each one works separately from others, and this problem is known to be responsible for many mistakes made during highly publicized criminal cases in India, like that of Aarushi Talwar.

Algorithmic opacity- With more and more use of artificial intelligence in pattern and data recognition, the issue of demographic bias, lack of transparency and weight of algorithm results in India remains unanswered, while being addressed in other jurisdictions already.

These are not merely administrative shortcomings; each has a constitutional dimension, since unreliable forensic evidence threatens both the accused's right to a fair trial and, where wrongful acquittals result, the victim's interest in an effective investigation.

VII. COMPARATIVE PERSPECTIVE: THE UNITED KINGDOM AND THE UNITED STATES

A. The United Kingdom

In the United Kingdom, regulation has taken place in an independent capacity. Since the closing down of the state run forensic lab, called the Forensic Science Service in 2012, the job was entrusted to the Forensic Science Regulator whose powers now lie under the statutory purview of the Forensic Science Regulator Act of 2021. The Regulator lays down and ensures quality standards in both public and private labs which fills exactly the accreditation lacunae that persists in the Indian system. In England, the courts too have evolved a jurisprudence around the issue of forensic reliability: in R v T, the Court of Appeal looked into the scientific validity of footwear mark comparison evidence, whereas R v Doheny & Adams warns the jury about the fallacious equation of the DNA match probability with the probability of guilt, known as 'prosecutor's fallacy'. The broader message for India is that a singular regulator appointed statutorily can achieve a lot towards harmonizing standards in a fragmented lab structure without re-legislating evidence laws

B. The United States

The American approach is based less on centralized regulation and more on judicial gatekeeping at the moment of admission. In Daubert v. Merrell Dow Pharmaceuticals, Inc., the

ISSN: 2582-6433

previous "general acceptance" test was superseded by an approach focusing on the reliability of the scientific methodology underlying expert testimony. This test was later applied to any kind of technical expertise in Kumho Tire Co. v. Carmichael and reiterated in General Electric Co. v. Joiner, confirming that trial judges may exclude expert testimony when the findings presented do not logically arise from the methodology adopted. An additional check on expert testimony can be found in the Sixth Amendment requirement of confrontation: in Melendez-Diaz v. Massachusetts, the Court ruled that forensic analysts had to be available for cross-examination before admitting their reports. This rule offers far greater protection compared to the Indian system, which allows the introduction of a laboratory report even without the presence of the analyst under Section 293 of the former Code, unless specifically contested. On the other hand, cases of failure such as the mistaken identification of fingerprints in Brandon Mayfield v. United States prove that neither decentralized regulation nor strict admissibility standards offer a full-proof protection against forensic mistakes.

C. Lessons for India

Taken together, the experiences of both the UK and US provide some transferrable lessons for India. First, a specialist regulatory body such as the Forensic Science Regulator may be used to establish common quality standards within India's disjointed laboratory network without the necessity of accreditation being dependent upon the voluntary action of each institution. Second, the development of a similar system to that of Daubert would increase the ability of judges to rigorously scrutinize any new or disputed forensic techniques by insisting that the court be satisfied of the reliability of the method in question prior to admitting the testimony of experts based thereupon. Third, the US approach regarding confrontation clause jurisprudence is a helpful lesson that convenience provisions such as Section 293 of the former code can undermine the right of the accused to effectively contest the forensic evidence against them.

VIII. TOWARDS REFORM: RECOMMENDATIONS

Based on the foregoing discussion, there are a number of concrete reforms that would improve the reliability and constitutionality of forensic practices in India.

1. National Forensic Science Authority- India needs its own independent statutory authority, analogous to the United Kingdom's Forensic Science Regulator, which would establish binding quality standards, require every forensic laboratory performing criminal work to be accredited, and perform regular audits.

ISSN: 2582-6433

2. Admissibility criteria- Criteria, either statutory or judicially formulated, regarding methodology, error rates, and peer review would provide courts with better standards against which to judge new forensic technologies prior to their admission into evidence, rather than leaving that task to the ad hoc opinions of judges concerning scientific validity.
3. Passage of the DNA Technology Regulation Bill with improved privacy protections- India's national database must include the concept of purpose limitation, strict data retention policies, independent supervision of the DNA Profiling Board, and statutory expungement rights for any individual acquitted or not charged.
4. Scientific literacy training for investigators, prosecutors, and judges- Misuses of forensics by investigators and prosecutors, whether by overstating DNA match probabilities or accepting blindly forensic laboratory determinations, can best be corrected through the scientific literacy of the judges evaluating that evidence.
5. Statutory procedures for chain of custody- Uniform procedures and strict compliance requirements with regard to the collection, labeling, transportation, and storage of physical evidence can prevent the occurrence of custody problems witnessed in cases like that of the Nithari case.
6. Forensic review boards for serious cases- In cases where conviction is heavily reliant upon the use of forensic evidence, an independent second opinion similar to those provided through the Innocence Project model in the U.S. could prevent wrongful convictions due to faulty forensic analysis.
7. Disclosure requirements for algorithmic tools- With machine learning playing a role in forensics, it is necessary to disclose the data and studies used to develop the tool prior to treating its output as evidence.

IX. CONCLUSION

Forensic science has revolutionized the evidentiary underpinnings of criminal law in India, by providing a set of methods which can prove beyond question the identity of actors, cause, and sequencing of events far more efficiently than the eyewitness narratives of a past era. But this revolution has always contained within it a constitutional stream running in the opposite direction. Article 20(3) prohibits the state from forcing an accused individual to serve as the source of testimonial evidence against his own person, as can be seen from the decision of the Supreme Court in Selvi v. State of Karnataka on a technique that digs into the mind and not just collects a bodily sample. Article 21, construed in light of the judgment in Puttaswamy,

ISSN: 2582-6433

mandates that any system of forensic data collection, especially any future national DNA database, be proportionate and purpose-driven, as well as genuinely overseen. And, finally, the right to a fair trial implies that forensic results must be verified, corroborated and challenged as necessary.

However, the experience of the UK and US demonstrates that, even when one of the two – centralized regulation and strict gatekeeping by the judiciary – is present, there is still no guarantee of the reliability of the forensic process in either system. However, what can be done is using these experiences as a pattern to build India's system. It needs a dedicated regulator to standardize practices in laboratories, stricter tests of admissibility to exclude unproven techniques from use, and adequate procedure rights to enable the defendant to effectively challenge the scientific prosecution. This can be achieved through investment in forensic infrastructure and education, legislative actions such as passing the DNA Technology Regulation Bill, and a readiness of the judiciary to accept forensic science as a tool rather than a substitute in search of truth. In that way, the potential of the union of science and law, which implies making the search for truth in the criminal trial more accurate and humane, will be realized.

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ISSN: 2582-6433

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