



ISSN: 2583-7753

LAWFOYER INTERNATIONAL JOURNAL OF DOCTRINAL LEGAL RESEARCH

[ISSN: 2583-7753]

Volume 4 | Issue 2

2026

DOI: <https://doi.org/10.70183/lijdlr.2026.v04.163>

© 2026 LawFoyer International Journal of Doctrinal Legal Research

Follow this and additional research works at: www.lijdlr.com

Under the Platform of LawFoyer – www.lawfoyer.in

After careful consideration, the editorial board of LawFoyer International Journal of Doctrinal Legal Research has decided to publish this submission as part of the publication.

In case of any suggestions or complaints, kindly contact (info.lijdlr@gmail.com)

To submit your Manuscript for Publication in the LawFoyer International Journal of Doctrinal Legal Research, To submit your Manuscript [Click here](#)

CRIMINAL INVESTIGATION IN THE MODERN ERA

Nivea Robin D Cruz¹

I. ABSTRACT

Criminal investigation has undergone a significant transformation in the modern era due to rapid technological advancements, globalization, and evolving patterns of crime. Traditional investigative methods, which relied heavily on eyewitness testimony and confessions, have gradually been supplemented and in some cases replaced by sophisticated tools such as forensic science, digital surveillance, artificial intelligence, and cyber investigation techniques. This research paper examines the evolution of criminal investigation in the modern era, focusing on its methods, challenges, and legal implications. The study also explores how investigative practices differ across jurisdictions, particularly between India and other developed countries like the United States and the United Kingdom. While developed countries often emphasize technological integration and procedural safeguards, developing systems face challenges including resource constraints, delays, and procedural inefficiencies. This paper attempts to focus on doctrinal and comparative methodology, analysing statutory frameworks, judicial interpretations as well as scholarly opinions. Key issues such as cybercrime, forensic advancements, human rights concerns, and cross-border investigations are discussed in detail. The research concludes that while modern investigative tools have enhanced efficiency and accuracy, they also raise concerns regarding privacy, misuse of power, and ethical boundaries. The study recommends legal reforms, improved training, technological investment, and international cooperation to strengthen investigative frameworks. Overall, the paper highlights that the future of criminal investigation lies in balancing technological innovation with legal safeguards and human rights protections.

II. KEYWORDS

Criminal Investigation, Forensic Science, DNA profiling, Comparative Law, Modern Policing.

¹ LL.M (Criminal Law), 3rd Semester, Student at Government Law College, Thiruvananthapuram (India). Email: robinnivea@gmail.com

III. INTRODUCTION AND RESEARCH PROBLEM

Criminal investigation is a vital part of the criminal justice system, which seeks to discover truth, identify offenders, and ensure justice. In the modern era, crime has evolved in complexity, ranging from cyber fraud and financial crimes to transnational terrorism. This shift has necessitated corresponding changes in investigative techniques. The Research Problem addressed in this paper is the gap between traditional investigative frameworks and the demands of modern criminal activity. Additionally, disparities in investigative practices between countries raise questions about efficiency, fairness, and adaptability.

The quality of the investigation conducted at the beginning of a case has a significant impact on the criminal justice system's efficacy. In an era marked by rapid scientific and technological advancement, traditional methods of crime detection are increasingly proving inadequate. A modern investigation demands a scientific approach, particularly in cases which rely on circumstantial evidence, where forensics play a decisive role in establishing the commission of a crime, identifying perpetrators, and determining the guilt or innocence of the accused.²

A crime scene, therefore, must be handled with utmost precision and care. The investigating officer bears the crucial responsibility of identifying, collecting, and preserving material evidence with probative value, while ensuring that it remains free from contamination or tampering. Any lapse at this stage can irreversibly weaken the prosecution's case. Scientific evidence, unlike oral testimony, is largely objective and not susceptible to human errors such as memory lapses, bias, or external influence.³ However, it is not infallible and must be carefully analyzed within the broader evidentiary framework.

The growing reluctance of witnesses to come forward, coupled with the increasing tendency of witnesses turning hostile due to intimidation or fear, has further heightened the importance of scientific evidence in criminal trials. In this context,

² S.S. Upadhyay, Importance of Proper & Scientific Investigation of Crimes (unpublished manuscript).

³ Ibid

courts have emphasized the role of forensic evidence in strengthening the administration of justice, as seen in *Dharam Deo Yadav v. State of Uttar Pradesh*.⁴

Despite these developments, the criminal justice system continues to face serious challenges arising from defective and incomplete investigations. Investigative lapses—often caused by inadequate training, lack of resources, ignorance of legal standards, or negligent practices frequently result in the acquittal of guilty individuals.⁵ The increasing sophistication of modern crimes has further exposed the limitations of conventional investigative techniques and highlighted the urgent need for capacity building within law enforcement agencies.

Ultimately, the success of a criminal trial rests on the foundation laid during the investigation. Courts can only adjudicate based on the evidence presented before them, and weak or flawed investigations inevitably undermine the cause of justice. Therefore, strengthening scientific investigation, improving forensic capabilities, and ensuring proper training of investigating officers are indispensable for enhancing the credibility and effectiveness of the criminal justice system.⁶

A. Research Objectives

1. To analyze the evolution of criminal investigation in the modern era.
2. To examine the role of technology in modern investigative processes.
3. To compare investigative systems in India and other countries.
4. To identify challenges faced by modern investigators.
5. To suggest reforms for improving investigative efficiency and fairness.

B. Research Questions

1. How has criminal investigation evolved in the modern era?
2. What role does technology play in modern investigations?

⁴ *Dharam Deo Yadav v. State of Uttar Pradesh*, (2014) 5 SCC 509

⁵ S.S. Upadhyay, *supra* note 1.

⁶ Jacob Joe Jerome E & Sugith Kumar, *Forensic DNA Fingerprinting: Reliability and Legal Admissibility in India*, 6(3) *Indian J. Legal Rev.* 464 (2026).

3. How do investigative practices differ between India and other countries?
4. What are the major challenges faced in modern criminal investigations?
5. What reforms are necessary to improve investigative systems?

C. Research Hypotheses

1. Criminal investigations have become far more accurate and efficient due to modern technology.
2. Investigative systems in developed countries are more advanced due to better resources and infrastructure.
3. There exists a need for stronger legal safeguards to prevent misuse of investigative powers.

D. Research Methodology

This research focuses on doctrinal and comparative methodology.

1. **Doctrinal Approach:** Analysis of legal provisions, case laws, and academic literature.
2. **Comparative Approach:** Examination of investigative frameworks in India, the United States, and the United Kingdom.
3. **Sources:** Secondary data including books, journals, government reports, and legal databases.

E. Literature Review

1. Scholars have extensively studied the transformation of criminal investigation. Early works emphasized traditional policing methods, while contemporary research focuses on forensic and digital advancements.
2. Studies highlight that forensic science has revolutionized evidence collection, while others point out the growing importance of cyber forensics. Comparative studies reveal that developed nations have better infrastructure and training systems, whereas developing countries struggle with backlog, corruption, and lack of expertise.

3. However, there is a research gap in integrating technological advancements with legal safeguards, particularly in developing jurisdictions.

IV. EVOLUTION OF CRIMINAL INVESTIGATION TECHNIQUES

The criminal investigation has undergone a profound transformation, evolving from rudimentary, intuition-based practices to a highly sophisticated, science-driven discipline. In ancient and medieval societies, criminal inquiries were largely dependent on superstition, coercion, and unverified confessions rather than empirical evidence. Early legal codes such as the Code of Hammurabi and principles embedded in Roman law outlined procedural aspects of justice but lacked structured forensic methodologies. Notably, early contributions to forensic thought emerged in China through *The Washing Away of Wrongs* (1247) by Song Ci, which described techniques for determining cause of death and analysing wounds marking one of the earliest documented efforts toward medical jurisprudence.⁷

The Enlightenment period of the 18th and 19th centuries marked the gradual infusion of scientific reasoning into criminal investigations. One of the most transformative developments was the formalization of fingerprint analysis. Francis Galton's work in 1892, building on earlier observations by William Herschel and Henry Faulds, demonstrated the uniqueness and permanence of fingerprints, thereby revolutionizing personal identification.⁸ Concurrently, systems such as anthropometry, developed by Alphonse Bertillon, sought to classify individuals based on physical measurements, reflecting an emerging reliance on objective data.⁹

The early 20th century witnessed the institutionalization of forensic science through the establishment of dedicated crime laboratories. Edmond Locard founded the first Police Crime Laboratory in France in 1910 and articulated the foundational basis that "every contact leaves a trace," now known as "Locard's Exchange Principle".¹⁰ This era also saw the development of standardized investigative protocols, including crime scene preservation, systematic evidence collection, and forensic documentation.

⁷ Song Ci, *The Washing Away of Wrongs* (1247).

⁸ Francis Galton, *Finger Prints* (1892)

⁹ Alphonse Bertillon, *Signaletic Instructions* (1893).

¹⁰ Edmond Locard, *L'Enquête Criminelle et les Méthodes Scientifiques* (1920)

Advances in serology, particularly following Karl Landsteiner's identification of blood groups, enabled investigators to incorporate biological evidence into criminal proceedings.¹¹

The latter half of the 20th century introduced transformative technological innovations, most notably DNA profiling. In 1984, Alec Jeffreys developed DNA fingerprinting, which was first applied in a criminal case in 1986 in the United Kingdom, fundamentally reshaping evidentiary standards.¹² Techniques evolved from Restriction Fragment Length Polymorphism (RFLP) to Short Tandem Repeat (STR) analysis, increasing both efficiency as well as accuracy. Additionally, emergence of digital forensics expanded the investigative domain to include electronic evidence such as emails, GPS data, and digital storage devices.

In the 21st century, criminal investigation has become increasingly interdisciplinary, integrating machine learning, artificial intelligence, and advanced imaging technologies. Tools such as 3D crime scene reconstruction, drones, and portable forensic devices facilitate real-time analysis, while AI-driven systems enhance pattern recognition and predictive modeling. These developments are complemented by the use of virtual and augmented reality for investigative reconstruction and professional training.

Alongside technological progress, the field has emphasized standardization and ethical accountability. Organizations like the Federal Bureau of Investigation, International Organization for Standardization (ISO) and National Institute of Standards and Technology (NIST) have established rigorous protocols to ensure reliability and transparency in forensic processes. These frameworks are critical in addressing concerns related to wrongful convictions and maintaining the integrity of the criminal justice system.

¹¹ Karl Landsteiner, On Agglutination of Normal Human Blood, 14 *Wiener Klinische Wochenschrift* 1132 (1901)

¹² Alec J. Jeffreys, Individual-Specific "Fingerprints" of Human DNA, 316 *Nature* 76 (1985)

V. ROLE OF TECHNOLOGY IN MODERN INVESTIGATION

The various technologies used in the modern era are discussed below:

A. DNA (Deoxyribonucleic Acid)

Deoxyribonucleic Acid (DNA) forms the genetic blueprint of all living organisms and has become an indispensable tool in forensic science. Its ability to uniquely identify individuals from biological materials such as blood, semen, saliva, hair, skin, and bones has significantly strengthened criminal investigations. The Supreme Court, in *Dharam Deo Yadav v. State of U.P.*¹³ and *Anil @ Anthony Arikswamy Joseph v. State of Maharashtra*¹⁴, recognized DNA profiling as a reliable scientific technique, while also cautioning that its accuracy depends upon strict adherence to laboratory quality control and procedures.

A crucial legal distinction exists between a DNA sample and a DNA profile. While the former refers to the biological substance collected, the latter is the analytical record used for comparison. The statutory recognition of DNA profiling under the Bharatiya Nagarik Suraksha Sanhita (BNSS), particularly under Sections 52, 53, and 54 (medical examination of accused and victim), reinforces its procedural validity. Additionally, in *Selvi v. State of Karnataka*¹⁵, the Supreme Court held that the collection of DNA samples does not violate Article 20(3) of the Constitution, as it constitutes physical evidence rather than testimonial compulsion.

The evidentiary value of DNA profiling has been consistently upheld by courts. In *Santosh Kumar Singh v. State (CBI)*¹⁶, the Court emphasized that DNA evidence is scientifically exact and courts should not substitute their own views for expert opinion. Similarly, in *Ranjitsing Brahmajeetsing Sharma v. State of Maharashtra*¹⁷, it was observed that DNA evidence assumes great significance when corroborated with other evidence on record. At the same time, where DNA results exclude the accused,

¹³ *Dharam Deo Yadav v. State of U.P.*, (2014) 5 SCC 509

¹⁴ *Anil @ Anthony Arikswamy Joseph v. State of Maharashtra*, (2014) 4 SCC 69.

¹⁵ *Selvi v. State of Karnataka*, (2010) 7 SCC 263.

¹⁶ *Santosh Kumar Singh v. State (CBI)*, (2010) 9 SCC 747

¹⁷ *Ranjitsing Brahmajeetsing Sharma v. State of Maharashtra*, (2005) 5 SCC 294.

such findings have been treated as conclusive in negating involvement in offences like rape.

However, the reliability of DNA evidence depends upon proper handling and preservation of samples. In *Sandeep v. State of U.P.*¹⁸, the Supreme Court held that delay in conducting DNA tests does not vitiate the findings unless it is shown that the samples were tampered with or improperly preserved. Thus, the burden lies on the party challenging the report to establish such defects.

In cases of sexual offences, statutory provisions under the BNSS mandate prompt DNA profiling. Section 53 BNSS requires a registered medical practitioner to prepare a DNA profiling report of the accused, while Section 184 BNSS mandates the same for the victim, subject to consent. These provisions ensure timely and scientific collection of evidence, thereby enhancing the quality of investigation and trial.

Despite its scientific reliability, courts have cautioned against the routine use of DNA testing, especially in matters of paternity. Under Section 116 of the Bharatiya Sakshya Adhiniyam (BSA), a presumption of legitimacy is attached to a child born during a valid marriage. In *Goutam Kundu v. State of W.B.*¹⁹ and *Bhabani Prasad Jena v. Orissa State Commission for Women*²⁰, the Supreme Court held that DNA tests should not be ordered as a matter of course and only in cases where a strong prima facie case is established.

The judicial approach has, however, evolved to prioritize scientific truth in appropriate cases. In *Nandlal Wasudeo Badwaik v. Lata Nandlal Badwaik*²¹, the Court held that where there is a conflict between a legal presumption under Section 116 BSA and scientifically accurate DNA evidence, the latter must prevail. Similarly, in *Dipanwita Roy v. Ronobroto Roy*²², the Court recognized DNA testing as the most legitimate means to establish allegations of infidelity and determine paternity, especially when no other evidence is available.

¹⁸ *Sandeep v. State of U.P.*, (2012) 6 SCC 107

¹⁹ *Goutam Kundu v. State of W.B.*, (1993) 3 SCC 418

²⁰ *Bhabani Prasad Jena v. Orissa State Commission for Women*, (2010) 8 SCC 633

²¹ *Nandlal Wasudeo Badwaik v. Lata Nandlal Badwaik*, (2014) 2 SCC 576

²² *Dipanwita Roy v. Ronobroto Roy*, (2015) 1 SCC 365

Therefore, DNA profiling has revolutionized the criminal justice system by providing a precise and objective method of identification. While its evidentiary value is substantial, courts continue to emphasize the need for procedural safeguards, statutory compliance under the BNSS and BSA, and careful judicial discretion. When properly applied, DNA evidence not only aids in securing convictions but also plays a crucial role in preventing miscarriages of justice.

B. Narco-Analysis Test in Criminal Investigation

Narco-analysis, also known as the “truth serum test” or “Amytal interview,” is a forensic interrogation technique in which certain psychoactive drugs are administered to a subject to induce a semi-conscious or hypnotic state. The term combines “narco” (referring to narcotics) and “analysis,” indicating psychological examination under drug influence. The technique became prominent in the early 20th century, with its formal conceptual use traced back to 1936. It is based on the assumption that when a person’s reasoning and inhibitory faculties are suppressed through drugs such as Sodium Pentothal, Sodium Amytal, or Scopolamine, they are more likely to disclose truthful information without deliberate deception.

The procedure involves intravenous administration of controlled doses of sedative-hypnotic drugs, often mixed in a saline or dextrose solution, under strict medical supervision. The dosage varies depending on the subject’s physical condition, age, and health. Once the subject enters a trance-like state, investigators pose structured questions, and responses are recorded audio-visually for evidentiary purposes. However, improper dosage or administration may lead to serious health risks, including coma or death, making the procedure highly sensitive and regulated.

From a legal standpoint, the admissibility and permissibility of narco-analysis have been subject to significant constitutional scrutiny. In *Selvi v. State of Karnataka*²³, a three-judge bench of the Supreme Court held that compulsory administration of narco-analysis, polygraph, and brain-mapping tests violates Article 20(3) of the

²³ *Selvi v. State of Karnataka*, (2010) 7 SCC 263.

Constitution, which protects against self-incrimination.²⁴ The Court clarified that these techniques involve testimonial responses extracted through external compulsion and therefore cannot be conducted without the subject's consent. Importantly, the Court also recognized the right to privacy and mental autonomy as part of Article 21.²⁵

Although earlier High Court decisions such as *Dinesh Dalmia v. State*²⁶, *Abhay Singh v. State of U.P.*²⁷, and *Santokben v. State of Gujarat*²⁸ had taken a more permissive view – suggesting that scientific techniques could assist investigation – the Supreme Court in *Selvi* conclusively settled the constitutional position against involuntary administration of such tests. It was also observed that investigative necessity cannot override fundamental rights.

In *Ram Singh v. Sonia*²⁹, the Supreme Court refrained from giving a definitive ruling on the evidentiary admissibility of narco-analysis results but indicated that such reports cannot be treated as substantive evidence. At best, they may assist investigation subject to corroboration under the Bharatiya Sakshya Adhiniyam (BSA), which governs admissibility of evidence in criminal trials.

The drugs commonly used in narco-analysis include Sodium Pentothal, Sodium Amytal, Seconal, Hyoscine (Scopolamine), and Phenobarbital. These substances depress the central nervous system, reduce inhibition, and place the subject in a hypnotic state. However, due to the potential for false confessions, memory distortion, and physiological risk, courts have consistently treated the technique with caution.

Judicial discourse also reflects a balance between investigative necessity and constitutional safeguards. While courts have acknowledged that modern scientific methods may assist in uncovering truth, they have emphasized that such methods cannot be imposed forcibly. The underlying principle reaffirmed in *Selvi* is that the

²⁴ Prof. R.K. Murali, *The Right to Silence in the Smartphone Era: An Examination of Article 20(3) and Forced Decryption*, 40 *Supremo Amicus* (Feb. 2026).

²⁵ Lairenjam Dhanamanjuri Devi, (2021) *Science on Trial: A Critical Study of The Role of DNA And Forensic Evidence in Indian Courts*, *Educational Administration: Theory and Practice*, 27(2) 1175-1187

²⁶ *Dinesh Dalmia v. State*, 2006 SCC OnLine Mad 1523.

²⁷ *Abhay Singh v. State of U.P.*, 2006 SCC OnLine All 1765

²⁸ *Santokben v. State of Gujarat*, 2008 SCC OnLine Guj 707

²⁹ *Ram Singh v. Sonia*, (2007) 3 SCC 1.

“discovery of truth” cannot be pursued through fundamental rights guaranteed under Article 20(3) and Article 21 of the Constitution.

Therefore, narco-analysis remains a controversial investigative tool in India. While it holds potential utility in aiding investigations, its constitutional limitations, procedural safeguards under BNSS provisions relating to medical examination, and evidentiary restrictions under the BSA ensure that it cannot replace traditional forms of admissible evidence. Its role is thus confined to assisting investigation, not forming the basis of conviction.

C. Polygraph (Lie Detector) Test in Criminal Investigation

The polygraph test, commonly known as the “lie detector test,” was invented by John A. Larson in 1921 while serving with the Berkeley Police Department in the United States. Larson’s instrument built upon earlier research by William Moulton Marston (1915), which explored the relationship between systolic blood pressure changes and deception. The polygraph later gained judicial attention in the landmark American case of *Frye v. United States*, where the standard for admissibility of scientific techniques was first discussed. The method is based on the assumption that deception causes involuntary physiological changes, which can be measured scientifically.

Historically, attempts at lie detection were primitive and often brutal, including trial-by-ordeal methods used in medieval England, such as immersion in water or carrying hot iron bars. These practices effectively declined after 1215, when the Fourth Lateran Council convened by Pope Innocent III prohibited clergy from participating in ordeals. Magna Carta, issued in the same year, was a distinct constitutional document that addressed the procedural rights of free men and the obligations of the Crown. The modern polygraph, however, represents a scientific shift from coercive practices to physiological measurement of truthfulness.

The polygraph test works on the principle that a person’s psychological stress during deception produces measurable changes in heart rate, respiration, blood pressure, and skin conductivity. A polygraph instrument records these involuntary responses through sensors attached to the subject’s body. The examiner then interprets the physiological tracings while posing structured questions. However, the test is not

considered infallible, as emotional stress, fear, or medical conditions may also influence physiological responses.

In criminal investigation, polygraph testing is used to assist in verifying statements, narrowing suspects, and guiding further inquiry. However, courts have consistently emphasized that it cannot replace thorough investigation or be treated as conclusive proof of guilt or innocence.

In India, the legal position on polygraph tests has been authoritatively settled by the Supreme Court in *Selvi v. State of Karnataka*³⁰. The Court held that compulsory administration of polygraph tests violates Article 20(3) of the Constitution, which protects against self-incrimination, and Article 21, which safeguards personal liberty and mental privacy. The Court clarified that such tests can only be conducted with the voluntary consent of the accused or witness.

Earlier judicial views had shown some acceptance of scientific interrogation techniques. For instance, in *Ram Chandra v. State of Maharashtra*³¹, it was observed that courts may direct polygraph tests in appropriate cases during investigation. However, this position was later restricted by the constitutional safeguards laid down in *Selvi*.

The Supreme Court further clarified that even where consent is given, the results of polygraph tests are not automatically admissible as substantive evidence under the Bharatiya Sakshya Adhinyam (BSA). At best, such results may be used for limited corroborative purposes if they meet strict procedural safeguards recommended by bodies such as the National Human Rights Commission (NHRC).³²

Thus, while polygraph testing has scientific utility in assisting investigation, its evidentiary value remains limited. It cannot be used as a substitute for admissible evidence, nor can it form the sole basis of conviction. The constitutional mandate ensures that investigative efficiency does not override fundamental rights, maintaining a balance between scientific advancement and individual liberty.

³⁰ *Selvi v. State of Karnataka*, (2010) 7 SCC 263.

³¹ *Ram Chandra v. State of Maharashtra*, (2004) 12 SCC 689

³²National Human Rights Commission, *Guidelines for the Administration of Polygraph Test* (2000).

D. Brain Mapping (P300) / Brain Fingerprinting Test

The Brain Mapping Test, commonly referred to as the P300 or Brain Fingerprinting Test, represents a significant development in neuro-forensic science aimed at detecting recognition-based brain responses associated with crime-related information. The technique was developed by Dr. Lawrence A. Farwell beginning in 1985, and its foundational scientific formulation was published in 1991 in a peer-reviewed study co-authored with Emanuel Donchin. The method, often described as “Brain Fingerprinting,” is premised on the scientific hypothesis that the human brain generates a distinct electrical response, known as the P300 wave, when it recognizes familiar or meaningful stimuli connected to stored memory.³³

The procedure involves a structured investigative process wherein the subject is initially interviewed to identify potential concealed information. Thereafter, electrodes are attached to the scalp of the subject, and the individual is placed before a computer interface. The subject is then exposed to visual or auditory stimuli, such as images or sounds related to the crime under investigation. The Electroencephalograph (EEG) records electrical activity in the brain, particularly detecting P300 responses, which are said to occur only when the brain recognizes “target stimuli” associated with prior knowledge of the incident. Unlike conventional interrogation, the subject is not asked direct questions during the test, thereby minimizing conscious manipulation of responses.³⁴

Closely associated with this technique is the concept of MERMER (Memory and Encoding Related Multifaceted Electroencephalographic Response), which is claimed to identify recognition patterns linked to crime-specific information. The underlying scientific assumption is that deception itself does not generate the response; rather, recognition of previously encoded memory triggers measurable neuro-electrical activity. EEG technology, which forms the basis of this test, records brain wave patterns such as alpha, beta, delta, and theta frequencies and translates them into

³³ Lawrence A. Farwell, *Brain Fingerprinting: A New Paradigm in Crime Detection* (Brain Wave Science, 1995)

³⁴ *Ibid*

electroencephalograms through amplified electrical signals.³⁵ These signals are captured with high temporal precision, often at the millisecond level, making EEG one of the most direct methods of measuring brain activity.

From a forensic neuroscience perspective, EEG-based brain mapping is considered a non-invasive technique capable of detecting cognitive responses to external stimuli. It has also been widely used in neurological diagnostics, including epilepsy, brain tumors, stroke, sleep disorders, coma, and brain death evaluation. However, despite its scientific sophistication, the technique remains subject to significant debate regarding its reliability, interpretative validity, and susceptibility to false positives or contextual distortions.

In the Indian legal context, the evidentiary value of brain mapping tests has not been conclusively established. In *Ranjitsing Brahmajeetsing Sharma v. State of Maharashtra*³⁶, the Supreme Court observed that the admissibility of scientific techniques such as brain mapping depends upon their demonstrated authenticity and probative reliability, and courts must evaluate supporting material before placing reliance upon such reports. The Court, however, refrained from giving a definitive ruling on its evidentiary admissibility, leaving the issue open for future judicial determination.

The constitutional framework governing such techniques was authoritatively settled in *Selvi*, where the Supreme Court held that compulsory administration of brain mapping (BEAP/P300), along with narco-analysis and polygraph tests, violates the protection against self-incrimination under Article 20(3) of the Constitution and infringes the right to privacy and personal liberty under Article 21.⁵ The Court clarified that such techniques cannot be conducted without the voluntary consent of the subject and that even consensual results cannot be treated as substantive evidence under the Bharatiya Sakshya Adhiniyam (BSA), 2023.

Thus, while brain mapping offers a scientifically innovative approach to detecting recognition memory, its legal utility in India remains confined to investigative

³⁵ J. R. Wolpaw et al., *Brain-Computer Interfaces: Principles and Practice*, 113 *Clin. Neurophysiology* 767 (2002) (discussing EEG-based neural signal detection).

³⁶ *Ranjitsing Brahmajeetsing Sharma v. State of Maharashtra*, (2005) 5 SCC 294.

assistance rather than evidentiary conclusiveness. The Indian judiciary has consistently emphasized that scientific advancement must operate within constitutional safeguards, ensuring that the pursuit of truth does not compromise fundamental rights or due process.

E. Blood Grouping Test and DNA Evidence in Determination of Paternity

The use of blood grouping tests in determining disputed paternity has long been recognized in forensic jurisprudence as a valuable piece of circumstantial scientific evidence.³⁷ Medical science enables classification of human blood into distinct groups, and comparative analysis can sometimes exclude or indicate the possibility of paternity. However, courts have consistently held that such tests are not conclusive proof of paternity and operate only within the realm of probability and exclusion rather than absolute determination.³⁸

The evidentiary value of blood grouping tests was examined by the Madhya Pradesh High Court in *Hargovind Soni v. Ramdulari*³⁹, wherein it was held that no person can be compelled to submit to a blood test against his will, and refusal to do so cannot, by itself, lead to an adverse inference. Similarly, the Bombay High Court in *Raghunath Eknath Hivale v. Shardabai Karbharikale*⁴⁰ emphasized the inherent limitations of blood grouping tests, observing that while they may indicate possibilities, they cannot conclusively establish paternity.

The Supreme Court has further clarified that forensic evidence such as blood stains or group analysis, though relevant, cannot override credible ocular evidence. In *Keshavlal v. State of M.P.*⁴¹, it was held that failure to obtain blood group or blood stain reports cannot discredit otherwise reliable eyewitness testimony. This, reflects the broader evidentiary principle that scientific evidence is corroborative rather than substitutive in nature under the Bharatiya Sakshya Adhinyam (BSA), 2023.

³⁷ Ivan Rathinam v. Milan Joseph, 2023 SCC OnLine Ker

³⁸ A. K. Sharma, Forensic Medicine and Toxicology 412–15 (2020).

³⁹ Hargovind Soni v. Ramdulari, AIR 1986 M.P. 57 (India).

⁴⁰ Raghunath Eknath Hivale v. Shardabai Karbharikale, AIR 1986 Bom. 386 (India)

⁴¹ Keshavlal v. State of M.P., (2002) 3 S.C.C. 254 (India).

From a forensic perspective, blood grouping evidence is primarily exclusionary. Scientific literature confirms that while blood tests cannot definitively prove paternity, they are highly effective in excluding individuals who cannot be the biological father. In *Bharti Raj v. Sumesh Sachdeo*⁴², the Allahabad High Court observed that blood test evidence may assist in determining paternity disputes, but courts must exercise caution and ensure that such requests are not made for collateral or fishing inquiries. The court further stressed that the welfare of the child and judicial protection against unnecessary stigmatization must guide judicial discretion. Statutory framework governing legitimacy is primarily contained in Section 116 of the Bharatiya Sakshya Adhiniyam (BSA), which provides that a child born during the continuance of a valid marriage is conclusively presumed to be legitimate unless non-access between the spouses is proved. This provision embodies a strong presumption in favour of legitimacy, rooted in public policy to protect the status of children and prevent social stigma. The Supreme Court in *Dukhtar Jahan v. Mohammed Farooq*⁴³ and *Amarjit Kaur v. Harbhajan Singh*⁴⁴ reiterated that courts should not lightly displace this presumption except on clear and cogent evidence.

In the context of scientific testing, courts have consistently held that DNA evidence, though highly reliable, does not automatically override the conclusive presumption under Section 116 BSA unless non-access is established. The Andhra Pradesh High Court in *Shaik Fakruddin v. Shaik Mohammed Hasan*⁴⁵ observed that DNA tests cannot, by themselves, rebut statutory presumption of legitimacy without proof of non-access.

However, the Supreme Court has recognized that in appropriate cases, DNA testing may be ordered to resolve allegations of infidelity or paternity disputes. In *Dipanwita Roy v. Ronobrota Roy*⁴⁶, the Court held that while such directions should be avoided where possible to protect the legitimacy of the child, DNA testing may be justified where allegations are specific and cannot be resolved otherwise. The Court further

⁴² *Bharti Raj v. Sumesh Sachdeo*, AIR 1986 All 259 (India).

⁴³ *Dukhtar Jahan v. Mohammed Farooq*, AIR 1987 S.C. 1049 (India)

⁴⁴ *Amarjit Kaur v. Harbhajan Singh*, (2003) 10 S.C.C. 228 (India)

⁴⁵ *Shaik Fakruddin v. Shaik Mohammed Hasan*, AIR 2006 A.P. 48 (India).

⁴⁶ *Dipanwita Roy v. Ronobrota Roy*, AIR 2015 S.C. 418 (India).

observed that refusal to undergo DNA testing may permit an adverse inference under Section 119 of the BSA.

In *Goutam Kundu v. State of W.B.*⁴⁷, the Supreme Court laid down guiding principles restricting routine blood or DNA tests, emphasizing that courts should not order such tests as a matter of course and must ensure strong prima facie grounds before doing so. Similarly, in *Shyam Lal v. Sanjeev Kumar*⁴⁸, it was reiterated that “access” under Section 116 refers to the possibility of sexual intercourse and not actual cohabitation, and that non-access must be strictly proved to rebut the presumption of legitimacy.

In conclusion, blood grouping tests and modern DNA profiling serve as powerful forensic tools in paternity disputes; however, their evidentiary value remains circumscribed by statutory presumptions under the BSA and judicial concern for protecting the legitimacy and dignity of children. Courts in India continue to strike a careful balance between scientific advancement and established principles of family law, ensuring that truth-seeking does not result in social harm or legal injustice.

F. Voice Identification, Voice Sample Analysis and Electronic Voice

Voice identification and voice analysis have emerged as significant tools in modern criminal investigation, particularly with the advancement of electronic surveillance and telecommunication technologies. Unlike traditional identification methods, voice-based identification relies on auditory recognition or scientific comparison of speech patterns recorded through electronic devices. However, Indian courts have consistently emphasized that such evidence must meet strict standards of reliability, authenticity, and procedural safeguards before being admitted under the Bharatiya Sakshya Adhiniyam, 2023 (BSA).

Voice identification by witnesses, particularly through short or incidental exposure, has been viewed with caution by courts. In *Inspector of Police, T.N. v. Palanisamy @ Selvan*⁴⁹, the Supreme Court held that identification of an accused based merely on brief or unfamiliar voice interactions is inherently unreliable, especially where

⁴⁷ *Goutam Kundu v. State of W.B.* (1993) 3 S.C.C. 418 (India).

⁴⁸ *Shyam Lal v. Sanjeev Kumar**, AIR 2009 S.C. 3115 (India).

⁴⁹ *Inspector of Police, T.N. v. Palanisamy @ Selvan*, AIR 2009 SC 1012 (India).

witnesses are not closely acquainted with the accused. This reflects the judicial concern regarding the subjective nature of auditory identification and its susceptibility to error.

The scientific process of voice sample comparison, however, has been recognized as constitutionally permissible. In *Ritesh Sinha v. State of U.P.*⁵⁰, the Supreme Court held that directing an accused to provide a voice sample does not violate Article 20(3) of the Constitution, as it constitutes physical evidence rather than testimonial compulsion. The Court further clarified that such samples may be obtained under judicial authorization by a Magistrate under procedural provisions analogous to Sections 52 and 176 of the Bharatiya Nagarik Suraksha Sanhita (BNSS). Earlier High Court decisions such as *CBI v. Abdul Karim Telgi*⁵¹ and *Mohan Singh v. State of Bihar*⁵² also supported the investigative utility of voice sampling in complex criminal cases.

However, the evidentiary admissibility of electronic voice records is subject to strict statutory compliance. The Supreme Court in *Sanjaysinh Ramrao Chavan v. Dattatray Gulabrao Phalke*⁵³ held that an alleged translated version of an inaudible voice recording cannot be relied upon unless the original source is produced and properly authenticated. The Court emphasized that authenticity and traceability of electronic evidence are essential requirements under Sections 61 and 63 of the Bharatiya Sakshya Adhinyam, 2023 (formerly Evidence Act principles).

Tape-recorded conversations and telephonic recordings have also been recognized as admissible evidence, provided strict safeguards are satisfied. In *R.M. Malkani v. State of Maharashtra*⁵⁴, the Supreme Court held that tape-recorded conversations are admissible under Section 6 of the BSA if the voice is properly identified, accuracy is established, and the possibility of tampering is excluded. This principle was further elaborated in *Ram Singh v. Col. Ram Singh*⁵⁵, where the Court laid down detailed

⁵⁰ *Ritesh Sinha v. State of Uttar Pradesh*, (2019) 8 SCC 1.

⁵¹ *CBI v. Abdul Karim Ladsab Telgi*, 2005 Cri. L.J. 2868 (Bom.) (India)

⁵² *Mohan Singh v. State of Bihar**, (2011) 75 A.C.C. 202 (S.C.).

⁵³ *Sanjaysinh Ramrao Chavan v. Dattatray Gulabrao Phalke*, (2015) 3 S.C.C. 123 (India).

⁵⁴ *R.M. Malkani v. State of Maharashtra*, AIR 1973 S.C. 157 (India).

⁵⁵ *Ram Singh v. Col. Ram Singh*, 1985 Supp. S.C.C. 611 (India).

conditions for admissibility, including proper sealing, custody, clarity of voice, and relevance of the conversation.

Subsequently, in *State (NCT of Delhi) v. Navjot Sandhu @ Afsan Guru*⁵⁶, the Court initially held that telephone call records are admissible without expert testimony. However, this position was later modified in *Anvar P.V. v. P.K. Basheer*⁵⁷, where a three-judge bench clarified that electronic records are inadmissible as secondary evidence without compliance with the mandatory certification requirement under Section 63 of the BSA. The jurisprudence thus establishes that while voice-based evidence—including voice samples, recorded conversations, and telephonic records—plays an increasingly important role in modern investigations, its admissibility is strictly governed by statutory safeguards and constitutional protections. Courts have consistently balanced the probative value of such evidence against the risks of manipulation, misidentification, and procedural irregularity.

In conclusion, voice identification and electronic voice evidence represent an evolving intersection between forensic science and evidentiary law. While Indian courts recognize their investigative utility, they have simultaneously imposed rigorous admissibility standards under the BSA and constitutional safeguards under Article 20(3), ensuring that technological advancement does not compromise fairness in criminal trials.

VI. EVIDENTIARY VALUE OF HANDWRITING, SIGNATURE COMPARISON AND EXPERT OPINION UNDER INDIAN EVIDENCE LAW

The evidentiary treatment of handwriting and signature comparison occupies a unique position in Indian criminal jurisprudence, where the law recognizes both judicial competence and expert assistance under the Bharatiya Sakshya Adhiniyam, 2023 (BSA) (formerly the Evidence Act framework). Unlike advanced forensic disciplines such as DNA profiling or neuro-scientific testing, handwriting comparison is not considered a strictly scientific discipline but rather an “art of observation”

⁵⁶ *State (NCT of Delhi) v. Navjot Sandhu @ Afsan Guru*, (2005) 11 SCC 600 (India).

⁵⁷ *Anvar P.V. v. P.K. Basheer*, (2014) 10 S.C.C. 473 (India)

developed through experience and training. Courts have consistently held that such comparison is subjective in nature and must be approached with caution.

In *J. Krishna v. Maliram Agarwal*⁵⁸, the Andhra Pradesh High Court observed that comparison of handwriting or signatures does not involve any precise scientific methodology but is an acquired skill. The Court further held that judicial officers, having received foundational training during induction and exposure to forensic institutions, are competent to exercise powers under Section 73 of the BSA to compare disputed and admitted signatures. It was emphasized that such judicial discretion is neither mechanical nor gullible but based on informed assessment.

The Supreme Court has similarly clarified the role of expert evidence under Section 39 of the BSA. In *State of H.P. v. Jai Lal*⁵⁹, it was held that for a witness to qualify as an expert, they must possess specialized skill, knowledge, or experience in the relevant field. Likewise, in *Ramesh Chandra Agrawal v. Regency Hospital Ltd*⁶⁰, the Court reiterated that expert opinion is only advisory in nature and must be independently evaluated by the court. Thus, expert evidence is never conclusive and remains subject to judicial scrutiny.

The statutory framework under Section 349 of the Bharatiya Nagarik Suraksha Sanhita (BNSS) empowers Magistrates to direct an accused (previously arrested in connection with the case) to provide specimen signatures or handwriting for investigative purposes. This provision strengthens investigative capabilities while maintaining procedural safeguards.

Further, under Sections 5 and 6 of the Identification of Prisoners Act, 1920, Magistrates are empowered to direct the collection of fingerprints, handwriting samples, palm prints, and other identifying physical characteristics. The constitutional validity of such provisions has been upheld on the ground that they do not amount to testimonial compulsion under Article 20(3). In the constitutional bench decision of *State of Bombay v. Kathi Kalu Oghad*⁶¹, it was held that giving fingerprints or specimen handwriting

⁵⁸ *J. Krishna v. Maliram Agarwal*, AIR 2013 A.P. 107 (India).

⁵⁹ *State of H.P. v. Jai Lal*, (1999) 7 S.C.C. 280 (India).

⁶⁰ *Ramesh Chandra Agrawal v. Regency Hospital Ltd.*, (2009) 6 S.C.C. 577 (India).

⁶¹ *State of Bombay v. Kathi Kalu Oghad*, AIR 1961 S.C. 1808 (India) (Constitution Bench).

does not amount to “being a witness against oneself.” This principle was reaffirmed in *Selvi and State through CBI v. M. Krishna Mohan*⁶².

In *Rabindra Kumar Pal v. Republic of India*⁶³, the Supreme Court reiterated that providing specimen handwriting, fingerprints, or bodily impressions is a permissible investigative procedure and does not violate constitutional safeguards against self-incrimination. Additionally, in *Jaspal Singh v. State of Punjab*⁶⁴, the Court observed that fingerprint identification is an exact science and highly reliable when properly examined by experts under Section 39 BSA.

Despite the availability of expert assistance, courts retain the discretion to compare handwriting or refuse to send documents for forensic examination where they are confident in their assessment. The Andhra Pradesh High Court in *J. Krishna v. Maliram Agarwal*⁶⁵ upheld such discretion, emphasizing that judicial evaluation of handwriting evidence is legally valid and not dependent on mandatory expert opinion.

Further expansion of expert opinion under Section 39 BSA includes technological forms of writing. In *State through CBI v. S.J. Choudhary*⁶⁶, a Constitution Bench held that typewriter examination falls within the ambit of expert evidence, recognizing it as a scientific method based on unique mechanical characteristics of devices.

In conclusion, handwriting and signature comparison remain an essential yet inherently subjective evidentiary tool within Indian criminal trials. While expert opinions under Section 39 BSA provide valuable assistance, their probative value is not conclusive. Courts retain ultimate authority to evaluate such evidence under Sections 73 BSA and related procedural provisions of BNSS, ensuring a balance between forensic assistance and judicial discretion.

⁶² State through S.P.E. & C.B.I. v. M. Krishna Mohan, AIR 2008 S.C. 368 (India).

⁶³ Rabindra Kumar Pal v. Republic of India, AIR 2011 S.C. 1436 (India).

⁶⁴ Jaspal Singh v. State of Punjab, AIR 1979 S.C. 1708 (India).

⁶⁵ J. Krishna v. Maliram Agarwal, AIR 2013 A.P. 107 (India).

⁶⁶ State through C.B.I. v. S.J. Choudhary, AIR 1996 S.C. 1491 (India) (Constitution Bench).

VII. ADMISSIBILITY OF ELECTRONIC EVIDENCE IN INDIA

The admissibility of electronic evidence under Indian law has undergone a decisive doctrinal shift with the Supreme Court's ruling in *Anvar P.V. v. P.K. Basheer*⁶⁷, wherein a three-judge bench unequivocally held that compliance with Section 65-B of the Indian Evidence Act, 1872 (now Section 63, BSA) is a *sine qua non* for the admissibility of secondary electronic records. This ruling marked a clear departure from the earlier position adopted in *State (NCT of Delhi) v. Navjot Sandhu*⁶⁸, where the Court had permitted reliance on secondary electronic evidence under general provisions relating to documentary evidence.

In *Anvar P.V.*, the Court clarified that Sections 65-A and 65-B constitute a complete code governing electronic evidence, thereby excluding the application of Sections 63 and 65 and reinforcing the principle of *generalia specialibus non derogant*. Consequently, any electronic record sought to be introduced as secondary evidence – such as CDs, VCDs, or digital storage devices – must be accompanied by a certificate under Section 65-B(4), certifying its authenticity and integrity.

The Court's reasoning in *Anvar P.V.* arose in the context of an election dispute involving allegations of corrupt practices substantiated through recorded speeches and digital media. The absence of the requisite certificate rendered such evidence inadmissible, thereby establishing a stringent evidentiary threshold. This doctrinal clarification not only overruled *Navjot Sandhu* to the extent of inconsistency but also instituted a mandatory procedural safeguard against tampering and unreliability in electronic evidence.

Subsequent judicial pronouncements, including *Kundan Singh v. State*⁶⁹, have reaffirmed this position, solidifying Section 65-B certification as a foundational requirement rather than a mere procedural formality. The implications of this ruling are far-reaching, particularly in criminal trials, election petitions, and cyber litigation where electronic records frequently constitute crucial evidence.

⁶⁷ *Anvar P.V. v. P.K. Basheer*, (2014) 10 SCC 473

⁶⁸ *State (NCT of Delhi) v. Navjot Sandhu*, (2005) SCC (Cri) 1715

⁶⁹ *Kundan Singh v. State*, 2015 SCC OnLine Del 13647 (India).

The jurisprudence was further consolidated in *Arjun Panditrao Khotkar v. Kailash Kushanrao Gorantyal*⁷⁰, wherein the Supreme Court reaffirmed the ratio in *Anvar P.V.* and overruled the contrary position taken in *Shafhi Mohammad v. State of Himachal Pradesh*⁷¹. The Court held that the requirement of a certificate under Section 65-B (4) is a condition precedent to admissibility of secondary electronic evidence, except in cases where the original electronic device itself is produced before the court.

Importantly, the Court introduced a pragmatic safeguard by empowering courts to summon the necessary certificate from the appropriate authority where a party is unable to produce it, thereby balancing strict compliance with practical feasibility. Recent developments, including rulings on call detail records and digital footage, continue to emphasize that non-compliance with Section 65-B renders such evidence inadmissible, and that oral testimony cannot substitute the statutory requirement, reflecting a consistent judicial preference for evidentiary certainty.

Significantly, the Bharatiya Sakshya Adhiniyam, 2023, which replaces the Indian Evidence Act, 1872, retains and substantially incorporates the framework governing electronic evidence. Provisions corresponding to Sections 65-A and 65-B (notably Sections 61-63 of the new enactment) affirm the legislative intent to preserve the principles laid down in *Anvar P.V.* and *Arjun Panditrao*. The continued insistence on certification underscores a commitment to maintaining authenticity and reliability in the treatment of electronic records, even as the statutory regime transitions into a modernized framework.

Parallel to these evidentiary developments, the judiciary has also recognized the evolving constitutional dimension of digital communication. In *Manik Taneja v. State of Karnataka*⁷², the Supreme Court acknowledged social media platforms such as Facebook as public forums facilitating the exercise of freedom of speech under Article 19(1)(a) of the Constitution. The Court held that mere expression of grievances against governmental machinery on such platforms does not constitute criminal conduct. This dual recognition of electronic records – as both evidentiary material and instruments

⁷⁰ *Arjun Panditrao Khotkar v. Kailash Kushanrao Gorantyal*, (2020) 7 SCC 1 (India)

⁷¹ *Shafhi Mohammad v. State of Himachal Pradesh*, (2018) 2 SCC 801 (India)

⁷² *Manik Taneja v. State of Karnataka*, (2015) 7 SCC 423 (India).

of democratic expression—highlights the need for a balanced legal framework that ensures procedural rigor while safeguarding fundamental rights in the digital age.

VIII. COMPARATIVE ANALYSIS OF CRIMINAL INVESTIGATION TECHNIQUES USED IN VARIOUS COUNTRIES

- 1. India:** India's investigative framework is firmly rooted in constitutional protections under Articles 20(3) and 21. In *Selvi*, the Supreme Court held that involuntary use of narco-analysis, polygraph, and brain mapping violates the right against self-incrimination and personal liberty. Even when voluntarily conducted, such techniques possess limited evidentiary value and are primarily investigative aids rather than substantive proof. India has, however, widely accepted DNA profiling as reliable evidence in criminal proceedings and paternity disputes, while blood grouping is considered corroborative and RNA-based techniques remain at a developmental stage. Electronic evidence is governed by a strict admissibility framework under Section 65-B, now reflected in the Bharatiya Sakshya Adhiniyam, 2023, requiring certification to ensure authenticity. Despite strong judicial safeguards in cases such as *Vineet Narain*⁷³ and *D.K. Basu*⁷⁴, India continues to face challenges in forensic infrastructure and uniform implementation.
- 2. United States:** The United States follows a rights-enforcing but technologically advanced model under the Fourth, Fifth, and Sixth Amendments. In *Mapp v. Ohio*⁷⁵, the exclusionary rule was established, while *Miranda v. Arizona*⁷⁶ mandates procedural safeguards during custodial interrogation. Polygraph evidence is generally inadmissible (*United States v. Scheffer*⁷⁷), and narco-analysis or brain mapping is not recognized. However, the U.S. leads globally in forensic advancements, including CODIS (DNA database), AI-driven predictive policing, and cyber forensics. A notable innovation is forensic genetic genealogy, which combines DNA data with genealogical databases to

⁷³ *Vineet Narain v. Union of India*, (1998) 1 SCC 226 (India)

⁷⁴ *D.K. Basu v. State of West Bengal*, (1997) 1 SCC 416 (India)

⁷⁵ *Mapp v. Ohio*, 367 U.S. 643 (1961).

⁷⁶ *Miranda v. Arizona*, 384 U.S. 436 (1966).

⁷⁷ *United States v. Scheffer*, 523 U.S. 303 (1998).

identify suspects in cold cases. The U.S. approach thus reflects strict constitutional compliance coupled with high technological integration.

3. **United Kingdom:** The United Kingdom operates under the Police and Criminal Evidence Act 1984 (PACE), ensuring uniform procedural safeguards in investigation. Courts emphasize evidentiary reliability, as seen in *R v Turnbull*⁷⁸, particularly in relation to identification evidence. Techniques such as narco-analysis and polygraph tests are not admissible in criminal trials. Instead, the UK relies heavily on CCTV surveillance, digital evidence systems, and recorded interrogations. Electronic evidence is admitted based on authenticity and reliability rather than rigid certification requirements, reflecting a structured yet flexible evidentiary model.
4. **Germany:** Germany represents a highly scientific and technologically advanced investigative system, governed by the Strafprozessordnung (StPO). It prioritizes objective forensic evidence over confessions, with extensive reliance on DNA profiling, digital reconstruction, and AI-assisted analysis. Polygraph-tests, narco-analysis, and brain mapping are not accepted due to concerns over reliability and human dignity. Germany's integrated Bundeskriminalamt (BKA) system and strong judicial oversight over surveillance contribute to a model characterized by precision, efficiency, and forensic accuracy.
5. **Canada:** Canada's system operates under the Canadian Charter of Rights and Freedoms, ensuring strong protections against self-incrimination and unreasonable search and seizure. Polygraph tests are generally inadmissible as evidence, though sometimes used as investigative tools. Canada employs national DNA databanks, advanced cybercrime units, and court-supervised surveillance mechanisms, balancing investigative efficiency with constitutional safeguards. Its approach reflects a moderate model, combining flexibility in evidence with strong rights protection.

⁷⁸ *R v Turnbull*, [1977] QB 224 (CA) (UK).

6. **Australia:** Australia follows a hybrid common law–statutory framework under the Evidence Act 1995. It has adopted advanced forensic databases, AI-assisted crime mapping, and digital evidence systems. Polygraph evidence is not admissible, and coercive techniques such as narco-analysis are not practiced. The system emphasizes mandatory electronic recording of interrogations and strong privacy protections under the Privacy Act 1988, reflecting a balanced integration of technology and accountability
7. **Japan:** Japan presents a distinct investigative model, historically reliant on confession-based processes but increasingly incorporating DNA evidence, digital forensics, and recorded interrogations. While polygraph tests have been used in limited contexts, their evidentiary value remains constrained. Japan is notable for its precision in trace evidence analysis and crime scene reconstruction, combining traditional investigative methods with modern scientific tools.
8. **Israel:** Israel stands out for its cutting-edge, intelligence-oriented investigative system, particularly in counter-terrorism contexts. It employs AI-based surveillance, biometric identification, and predictive analytics, alongside advanced cyber forensic capabilities. While coercive techniques are regulated, Israel’s system is unique for its integration of national security intelligence with criminal investigation, making it one of the most technologically sophisticated frameworks globally.

Therefore, a comparative analysis reveals that India adopts a constitutionally cautious approach, limiting intrusive techniques and imposing strict evidentiary standards, particularly for electronic evidence. In contrast, countries like the United States and United Kingdom emphasize procedural safeguards and technological enforcement, while Germany prioritizes scientific precision and forensic reliability. Canada and Australia demonstrate balanced hybrid models, integrating technology with rights protection, whereas Japan and Israel showcase unique investigative innovations, including advanced surveillance and forensic reconstruction.

Globally, there is convergence in the acceptance of DNA evidence and digital forensics, while divergence persists regarding behavioural and coercive techniques such as narco-analysis and polygraph tests. The emerging trend reflects a shift toward AI-driven, data-centric, and scientifically validated investigative methods, with courts continuing to safeguard fundamental rights against invasive or unreliable techniques.

IX. SUGGESTIONS AND RECOMMENDATIONS

- 1. Strengthening DNA Profiling and Forensic Standards:** The rapid integration of scientific and technological tools into criminal investigation necessitates a careful balancing of efficiency and constitutional safeguards. It is recommended that the use of techniques such as DNA profiling be strengthened through the establishment of standardized protocols and independent forensic laboratories to minimize the risk of contamination and misinterpretation. While DNA evidence is often perceived as conclusive, its reliability depends significantly on proper collection, preservation, and analysis; therefore, statutory guidelines and strict chain-of-custody requirements must be uniformly enforced. India currently lacks a comprehensive standalone statute governing the collection, storage, and use of DNA data. Although the DNA Technology (Use and Application) Regulation Bill, 2019 sought to establish such a framework, it was not enacted and was withdrawn by the Government in 2023. It is therefore recommended that fresh legislative action be undertaken to enact a comprehensive DNA regulation framework that addresses privacy concerns, establishes strict oversight mechanisms, and prevents misuse of genetic data.
- 2. Regulation of Polygraph Tests and Narco-Analysis:** Further, the continued use of investigative techniques such as polygraph tests and narco-analysis must be approached with caution, particularly in light of their questionable scientific reliability and potential infringement of the right against self-incrimination. The landmark judgment in *Selvi* clearly establishes that involuntary administration of such techniques violates personal liberty and mental privacy.

It is therefore recommended that these methods, if used at all, should be strictly voluntary and limited to investigative leads rather than evidentiary purposes. Clear statutory regulation, rather than reliance on judicial interpretation alone, would ensure uniformity and prevent abuse by investigative agencies.

- 3. Modernization of Traditional Forensic Techniques:** In addition, the evidentiary value of traditional forensic methods such as blood grouping has diminished with the advent of more precise technologies like DNA profiling; however, such methods may still serve a corroborative function in resource-constrained settings. It is recommended that forensic infrastructure be modernized across jurisdictions to reduce dependence on outdated techniques and to ensure equitable access to advanced investigative tools. Investment in training law enforcement personnel in scientific evidence handling is equally essential to prevent procedural lapses that could weaken prosecution cases.
- 4. Admissibility and Integrity of Electronic Evidence:** The growing reliance on electronic evidence presents both opportunities and challenges for the criminal justice system. Digital data such as emails, call records, and surveillance footage have become crucial in modern investigations, yet their admissibility hinges on proper authentication and compliance with procedural requirements. The framework under the Bharatiya Sakshya Adhiyam highlights the importance of certification for electronic records, but practical implementation remains inconsistent. It is recommended that clearer guidelines and technological support systems be developed to ensure the integrity and admissibility of digital evidence. Additionally, robust cybersecurity measures must be adopted to prevent tampering and unauthorized access.
- 5. Protection of Privacy and Human Rights in Investigation:** Finally, it is imperative to adopt a rights-based approach to criminal investigation that prioritizes human dignity and due process. The increasing use of surveillance and data-driven investigative methods raises significant concerns regarding privacy and state overreach. Judicial recognition of the right to privacy in *K.S.*

*Puttaswamy*⁷⁹ underscores the need for proportionality and legality in the use of intrusive investigative techniques. Accordingly, comprehensive data protection legislation and independent oversight mechanisms should be established to regulate the collection and use of personal data in criminal investigations.

X. CONCLUSION

The transformation of criminal investigation in the modern era reflects a decisive shift from confession-centric methods to a science-driven and technology-oriented approach. Techniques such as DNA profiling, electronic evidence analysis, and advanced forensic tools have significantly improved the accuracy and efficiency of investigations, enabling law enforcement agencies to reconstruct events with greater precision. However, this progress is accompanied by complex legal and ethical challenges, particularly concerning the protection of fundamental rights and the prevention of investigative overreach. The continued debate surrounding the admissibility and legitimacy of techniques such as polygraph tests and narco-analysis illustrates the tension between the pursuit of truth and the preservation of individual liberties, as highlighted in *Selvi*.

At the same time, the increasing reliance on digital evidence has reshaped evidentiary standards and judicial processes. Provisions such as Section 65B of the Indian Evidence Act (now Section 63 of BSA) have attempted to regulate the admissibility of electronic records, yet practical challenges in authentication and enforcement persist. Similarly, the recognition of the right to privacy in *Justice K.S. Puttaswamy* underscores the necessity of ensuring that investigative advancements do not erode constitutional guarantees. These developments highlight the need for a coherent legal framework that accommodates technological innovation while maintaining procedural fairness.

Ultimately, the effectiveness of modern criminal investigation depends not only on the adoption of advanced techniques but also on the integrity of their application within the rule of law. A balanced approach—grounded in scientific reliability, legal

⁷⁹ AIR 2017 SC 4161

accountability, and respect for human rights – is essential to sustain public confidence in the criminal justice system. As technology continues to evolve, the law must respond proactively through legislative reform, judicial vigilance, and institutional capacity-building to ensure that the quest for justice remains both effective and equitable.

XI. REFERENCES

A. Case laws

1. *Anvar P.V. v. P.K. Basheer*, (2014) 10 S.C.C. 473 (India)
2. *Arjun Panditrao Khotkar v. Kailash Kushanrao Gorantyal*, (2020) 7 SCC 1 (India)
3. *Bhabani Prasad Jena v. Orissa State Commission for Women*, (2010) 8 SCC 633
4. *Bharti Raj v. Sumesh Sachdeo*, AIR 1986 All 259 (India).
5. *CBI v. Abdul Karim Ladsab Telgi*, 2005 Cri. L.J. 2868 (Bom.) (India)
6. *D.K. Basu v. State of West Bengal*, (1997) 1 SCC 416 (India)
7. *Dharam Deo Yadav v. State of Uttar Pradesh*, (2014) 5 SCC 509
8. *Dipanwita Roy v. Ronobroto Roy*, (2015) 1 SCC 365.
9. *Dukhtar Jahan v. Mohammed Farooq*, AIR 1987 S.C. 1049 (India)
10. *Goutam Kundu v. State of W.B.* (1993) 3 S.C.C. 418 (India).
11. *Inspector of Police, T.N. v. Palanisamy @ Selvan*, AIR 2009 SC 1012 (India).
12. *J. Krishna v. Maliram Agarwal*, AIR 2013 A.P. 107 (India).
13. *Jaspal Singh v. State of Punjab*, AIR 1979 S.C. 1708 (India).
14. *Justice K.S. Puttaswamy (Retd.) v. Union of India*, (2017) 10 S.C.C. 1 (India).
15. *Keshavlal v. State of M.P.*, (2002) 3 S.C.C. 254 (India).
16. *Kundan Singh v. State*, 2015 SCC OnLine Del 13647 (India).
17. *Mapp v. Ohio*, 367 U.S. 643 (1961).
18. *Miranda v. Arizona*, 384 U.S. 436 (1966).
19. *Nandlal Wasudeo Badwaik v. Lata Nandlal Badwaik*, (2014) 2 SCC 576
20. *R v Turnbull*, [1977] QB 224 (CA) (UK).
21. *R.M. Malkani v. State of Maharashtra*, AIR 1973 S.C. 157 (India).
22. *Rabindra Kumar Pal v. Republic of India*, AIR 2011 S.C. 1436 (India).
23. *Ram Chandra v. State of Maharashtra*, (2004) 12 SCC 689\

24. *Ram Singh v. Col. Ram Singh*, 1985 Supp. S.C.C. 611 (India).
25. *Sanjaysinh Ramrao Chavan v. Dattatray Gulabrao Phalke*, (2015) 3 S.C.C. 123 (India).
26. *Santokben v. State of Gujarat*, 2008 SCC OnLine Guj 707
27. *Santosh Kumar Singh v. State (CBI)*, (2010) 9 SCC 747
28. *Selvi v. State of Karnataka*, (2010) 7 SCC 263.
29. *Shaik Fakruddin v. Shaik Mohammed Hasan*, AIR 2006 A.P. 48 (India).
30. *Shyam Lal v. Sanjeev Kumar*, AIR 2009 S.C. 3115 (India).
31. *State (NCT of Delhi) v. Navjot Sandhu @ Afsan Guru*, (2005) 11 SCC 600 (India).
32. *State (NCT of Delhi) v. Navjot Sandhu*, (2005) SCC (Cri) 1715
33. *State of Bombay v. Kathi Kalu Oghad*, AIR 1961 S.C. 1808 (India) (Constitution Bench).
34. *State through S.P.E. & C.B.I. v. M. Krishna Mohan*, AIR 2008 S.C. 368 (India).
35. *United States v. Scheffer*, 523 U.S. 303 (1998).
36. *Vineet Narain v. Union of India*, (1998) 1 SCC 226 (India)

B. Legislations

1. Bharatiya Nagarik Suraksha Sanhita (BNSS), 2023
2. Bharatiya Nyaya Sanhita (BNS), 2023
3. Bharatiya Sakshya Adhinyam (BSA), 2023
4. Code of Criminal Procedure (CrPC), 1973
5. Indian Evidence Act, 1872
6. The Constitution of India, 1950

C. Books

1. EDMOND LOCARD, L'ENQUÊTE CRIMINELLE ET LES MÉTHODES SCIENTIFIQUES (1920).
2. FRANCIS GALTON, FINGER PRINTS (1892).
3. LAWRENCE A. FARWELL, BRAIN FINGERPRINTING: A NEW PARADIGM IN CRIME DETECTION (Brain Wave Sci. 1995).

4. RATANLAL & DHIRAJLAL, THE INDIAN PENAL CODE (34th ed., LexisNexis 2017).

D. Journal articles and Online Sources

1. Goswami, G.K., Goswami, S. (2018). Three Decades of DNA Evidence: Judicial Perspective and Future Challenges in India. In: Dash, H., Shrivastava, P., Mohapatra, B., Das, S. (eds) DNA Fingerprinting: Advancements and Future Endeavors. Springer, Singapore.
https://doi.org/10.1007/978-981-13-1583-1_11
2. Newburn, T., Williamson, T., & Wright, A. (Eds.). (2007). Handbook of Criminal Investigation (1st ed.). Willan.
<https://doi.org/10.4324/9780203118177>
3. S.S. Upadhyay, Importance of Proper & Scientific Investigation of Crimes (unpublished manuscript).