



FROM TESTIMONY TO TECHNOLOGY: THE INTEGRATION OF FORENSIC SCIENCE IN MODERN CRIMINAL INVESTIGATION

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Abstract-

Forensic science has changed the modern legal system by moving away from guesswork, forced confessions, and unreliable eyewitnesses, and instead using solid, scientific evidence. This paper looks at how forensic science helps collect evidence, identify victims and criminals, reconstruct crime scenes, and stop wrongful convictions. It explains important methods like DNA testing, fingerprinting, computer forensics, and lie detector tests, while looking at how Indian laws (like the Bharatiya Sakshya Adhiniyam, 2023) and landmark Supreme Court cases handle them.

Ultimately, science is a powerful tool to help deliver fair justice, but it only works well when handled carefully and watched over strictly by the courts.

Keywords: Forensic science, Crime scene reconstruction, Evidence-Based Policing, DNA Profiling, Forensic Odontology, Voice Print Analysis, Narcotic Analysis, Brain Mapping, Expert Evidence.

INTRODUCTION AND HISTORY

For a long time, legal systems relied on oral stories, beliefs, and confessions to figure out the truth. Today, forensic science provides objective and scientific methods to help courts find the facts. The word "forensic" comes from an old Latin word, *forensis*, meaning "of the forum," where ancient Romans argued legal disputes openly.

Key milestones in forensic history include:

- * Early Beginnings: China used fingerprints as early as 700 A.D. to identify people, and Roman and Arab cultures used medical exams to find causes of injury and death.
- * Scientific Crime Solving: In 1893, Hans Gross published a famous book that combined science (like physics and chemistry) with crime investigation, earning him the title of the "Father of Criminalistics".
- * The DNA Breakthrough: In 1985, Sir Alec Jeffreys discovered DNA fingerprinting, completely changing

how police catch criminals around the world.

* In India, forensic science grew during and after the colonial period to fight organized crime, terrorism, and cybercrimes. Today, courts rely heavily on science, though they balance it carefully with personal rights and fair trial rules.

MAIN ROLE OF FORENSIC SCIENCE IN CRIMINAL INVESTIGATION

* From Crime Scene to Courtroom: Investigations start at the crime scene, where experts collect, save, and analyze physical and digital clues. The Supreme Court of India has warned that if police do a sloppy job collecting evidence or break the "chain of custody" (the documented trail of how evidence was handled), it can ruin a criminal case.

* Identifying Suspects and Victims: When bodies are badly burned, decomposed, or part of a massive disaster, regular identification is impossible. Techniques like DNA testing, dental analysis (odontology), and matching skulls with photographs help correctly identify victims and criminals.

* Proof and Protection: Forensic science acts as a double-edged sword: it supports the prosecution by proving an accused person was at the crime scene, but it also helps exclude innocent people who were wrongfully blamed, preventing tragic mistakes.

* Moving Away from Forced Confessions: In the past, police heavily relied on forcing confessions out of suspects under pressure. Today, the law encourages evidence-based policing.

KEY FORENSIC TECHNIQUES AND LANDMARK CASE LAWS

Indian courts have created important rules to balance scientific investigation with personal rights (such as Article 20(3) against self-incrimination and Article 21 protecting personal liberty and privacy).

Fingerprinting :-

* How it works: Every human has unique patterns on their fingertips (loops, whorls, arches) that never change from birth to death.

* Legal status: Fully accepted by Indian courts as expert evidence.

* Key Case (State of Bombay v. Kathi Kalu Oghad, 1961): The Supreme Court held that taking a person's fingerprints or handwriting samples does not violate their right against self-incrimination under Article 20(3) because they are physical identification traits, not personal statements.

DNA Profiling:-

* How it works: DNA is present in almost every cell of the body (blood, hair, saliva, bones) and acts like a biological barcode unique to each individual.

* Legal status: Considered one of the most reliable forms of circumstantial evidence.

* Key Cases:

* In *Mukesh v. State (NCT of Delhi) / The Nirbhaya Case* (2017), DNA and medical evidence played a decisive role in conclusively establishing the guilt of the accused.

* In *Karandeep Sharma v. State of Uttarakhand* (2025), the Supreme Court ruled that DNA reports cannot be treated as a "black-box" substitute; keeping an unbroken chain of custody and bringing the scientific expert to court to testify are mandatory under Article 21.

Scientific Interrogation (Narco-Analysis, Polygraph, and Brain Mapping):-

- * How it works: Narco-analysis (truth serum), polygraph (lie detector), and Brain Mapping/BEAP (P-300 brain waves) attempt to extract information from a suspect's mind.

- * Key Case (Selvi v. State of Karnataka, 2010): The Supreme Court ruled that forcing someone to take these tests violates their constitutional right against self-incrimination (Article 20(3)) and mental privacy/liberty (Article 21). They are unconstitutional as forced measures and cannot be used as direct proof in court, though voluntary tests can sometimes provide investigative leads.

Voice Print Analysis:-

- * How it works: Using computer graphs to compare an unknown recorded voice (like a threat or ransom call) with a suspect's voice sample.

- * Legal status: Admissible as expert evidence under Section 39 of the Bharatiya Sakshya Adhiniyam, 2023, if proven authentic and untampered with.

- * Key Case (Ritesh Sinha v. State of Uttar Pradesh, 2019): The Supreme Court ruled that magistrates have the power to order a suspect to give a voice sample, and doing so does not violate Article 20(3).

Cyber Forensics:-

- * How it works: Recovering deleted files, emails, hard drives, and tracking IP addresses to solve digital crimes.

- * Legal status: Electronic records are fully accepted in India.

- * Key Case (Anvar P.V. v. P.K. Basheer, 2014): The Supreme Court ruled that electronic records must be accompanied by a special official certificate (formerly Section 65B of the Indian Evidence Act, now Section 63 of the Bharatiya Sakshya Adhiniyam, 2023) to be legally admissible, unless the original device is produced in court.

CHALLENGES IN INDIA

Even though forensic science is powerful, India faces several hurdles:

- * Poor Infrastructure: Many labs lack modern equipment, funding, and proper facilities.

- * Shortage of Experts: There are not enough trained forensic professionals, which causes major delays in solving cases.

- * Investigative Mistakes: Police officers often lack proper training in collecting evidence, which can accidentally ruin or contaminate crime scenes.

- * Lack of Independence: Most government forensic labs are controlled by the police, which sometimes raises questions about their absolute neutrality.

CONCLUSION

Forensic science has successfully modernized the Indian justice system by replacing guesswork with objective facts. New laws like the Bharatiya Sakshya Adhiniyam, 2023 have made it easier to bring digital and scientific evidence into courts. However, science is meant to assist judges, not replace them. To make the system truly fair and efficient, India needs to invest heavily in better lab equipment, independent facilities, proper training, and strict adherence to human rights.

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