A CRITICAL EXAMINATION OF BITE MARK ANALYSIS EVIDENTIARY VALUE IN INDIAN CRIMINAL TRIALS THROUGH FORENSIC ODONTOLOGY: A COMPARATIVE STUDY WITH WESTERN JURISDICTIONS

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ABSTRACT

Bite mark analysis, a branch of forensic odontology, has occupied a contested position in criminal evidence for several decades. In India, courts have periodically admitted such evidence under *Section 45 of the Indian Evidence Act, 1872* and now under *Section 39 of the Bharatiya Sakshya Adhiniyam, 2023* without critically evaluating the scientific validity of the underlying methodology. This paper examines the reliability of bite mark evidence within the Indian criminal justice framework and situates it in comparative perspective with developments in the United States, the United Kingdom, and Australia.

Drawing on forensic scientific literature, judicial decisions of the Supreme Court of India and various High Courts, and the foundational critique articulated in the National Academy of Sciences Report (2009) and the PCAST Report (2016), the paper argues that the current admissibility framework is structurally inadequate to prevent the introduction of scientifically unvalidated forensic testimony into high-stakes criminal proceedings. India-specific challenges, including tropical climate conditions, the absence of a national dental database, inadequate laboratory infrastructure, and the lack of standardised forensic odontological protocols, further compound the generic limitations of bite mark analysis. The paper advances a set of legislative, institutional, and judicial reforms aimed at aligning Indian evidentiary standards with the emerging global scientific consensus, with the aim of reducing the systemic risk of wrongful convictions attributable to contested forensic testimony.

Keywords: *Bite Mark Analysis, Forensic Odontology, Indian Evidence Act, Expert Opinion, Daubert Standard, Bharatiya Sakshya Adhiniyam, Wrongful Conviction, Reliability of Forensic Evidence.*

I. INTRODUCTION

The intersection of law and science in the courtroom has always been an uneasy alliance. Courts depend on forensic evidence to reconstruct events that no living witness can fully describe; yet, in extending judicial confidence to scientific disciplines, they often lack the tools to distinguish between genuinely reliable methodology and what critics have aptly termed "junk science." Bite mark analysis presents one of the most striking illustrations of this tension. Belonging to the broader discipline of forensic odontology, it involves the comparison of dental impressions left on human skin or other substrates with the known dentition of a suspected individual. On the surface, it offers a seemingly precise and objective identification mechanism. In practice, its scientific foundations have proved considerably more fragile.

Bite mark analysis first gained judicial prominence in *People v. Marx (1975)*[1] in the United States, and subsequently found its way into Indian courts through the expansive gateway of *Section 45 of the Indian Evidence Act, 1872*[2]. That provision, which renders the opinions of persons specially skilled in science or art relevant as expert evidence, has served as the legislative entry point for forensic odontological testimony in criminal proceedings. Indian courts in cases ranging from sexual assault and child abuse to homicide have relied upon bite mark evidence as corroborative proof linking suspects to crime scenes, often in the absence of other definitive physical evidence.

What makes this judicial acceptance troubling is that it has, by and large, outpaced the scientific validation of the methodology itself. The field is beset by well-documented problems: the absence of standardised collection and analysis protocols; the inherent elasticity of human skin as a recording substrate; significant disagreement among examiners; and the complete absence of a population-specific dental database for India. The country's predominantly tropical climate introduces additional variables accelerating tissue degradation and distortion that render the controlled-trial accuracy figures cited in international studies largely inapplicable to Indian forensic conditions.

The enactment of the *Bharatiya Nyaya Sanhita (BNS)*, the *Bharatiya Nagarik Suraksha Sanhita*

[1] People v. Marx, 54 Cal.App.3d 100 (1975). This was the first American appellate court to uphold a conviction based on bite mark comparison evidence, establishing a precedent that influenced courts globally.
[2] Section 45, Indian Evidence Act, 1872: When the Court has to form an opinion upon a point of science or art, the opinions of persons specially skilled in such science or art are relevant facts. Such persons are called experts

(BNSS), and the *Bharatiya Sakshya Adhiniyam (BSA)* in 2023 which came into force on 1 July 2024 as replacements for the Indian Penal Code, Code of Criminal Procedure, and Indian Evidence Act respectively presents both an opportunity and a challenge[3]. While these statutes expand and modernise India's criminal justice architecture, they do not introduce any reliability-based threshold for the admissibility of scientific expert evidence. The structural inadequacy of the old framework is thus preserved under the new one. It is this misalignment that the present paper seeks to examine and address.

(i) Object and Scope of the Study

The primary purpose of this research is to critically assess whether bite mark evidence, as currently admitted and evaluated in Indian criminal proceedings, meets the minimum standards of scientific reliability that justice requires. The study traces the historical development of forensic odontology in the Indian legal context; analyses the statutory framework governing expert testimony under both the Indian Evidence Act and the Bharatiya Sakshya Adhiniyam; examines landmark judicial decisions involving bite mark evidence; evaluates the scientific and empirical dimensions of the methodology with specific reference to Indian conditions; and proposes a comprehensive reform agenda.

The scope extends across the entire lifecycle of bite mark evidence from documentation at the crime scene to testimony before the court and encompasses comparative analysis of the United States, the United Kingdom, and Australia. It draws on forensic scientific scholarship to the extent necessary for legal evaluation, without purporting to be a clinical or experimental scientific study. The research is anchored in legal methodology, supplemented by forensic scientific literature review.

(ii) Research Problem / Research Statement

Despite persistent scientific doubt about its validity, bite mark analysis continues to be admitted and acted upon in serious criminal proceedings in India, including trials for murder and sexual assault. The Supreme Court's endorsement of bite mark evidence in significant decisions has institutionalised a judicial culture that accords evidentiary weight to forensic odontological opinion without adequate scrutiny of its empirical basis. This practice is compounded by the

[3] The Bharatiya Nyaya Sanhita (Act No. 45 of 2023), Bharatiya Nagarik Suraksha Sanhita (Act No. 46 of 2023), and Bharatiya Sakshya Adhiniyam (Act No. 47 of 2023) came into force on 1 July 2024, replacing the Indian Penal Code 1860, Code of Criminal Procedure 1973, and Indian Evidence Act 1872 respectively.

absence of standardised forensic protocols, the non-existence of a national dental database, and tropical environmental conditions that rapidly degrade bite mark substrates all of which are distinctly Indian problems with no adequate reflection in the legislative or judicial response.

The new statutory framework under the BSA and BNSS, while modernising several aspects of criminal procedure and evidence, does not replicate the reliability-based admissibility standards of the kind developed under *Daubert v. Merrell Dow Pharmaceuticals (1993)*[4] in the United States or under *R v. Otway (2011)*[5] *in England and Wales*. This legislative gap leaves courts without the formal tools to distinguish reliable forensic science from contested methodology. The research problem, stated directly, is this: the admissibility framework for bite mark evidence in India is out of alignment with the scientific consensus on its reliability, and this misalignment creates a systemic risk of wrongful convictions that the new criminal justice codes have failed to address.

(iii) Research Questions

This paper is guided by the following questions:

- First, does the current scientific consensus on bite mark reliability support the evidentiary weight accorded to it by Indian courts?
- Second, how do the admissibility provisions under the Indian Evidence Act and its successor legislation govern forensic odontological testimony, and what are their structural inadequacies?
- Third, have the Supreme Court and High Courts of India evaluated bite mark evidence with the scientific rigour the methodology demands?
- Fourth, what India-specific contextual factors tropical climate, inter-examiner variability, infrastructure deficit additionally undermine bite mark reliability?
- Fifth, what legislative, institutional, and procedural reforms are necessary to ensure that such evidence, if admitted, is evaluated with appropriate scientific scrutiny?

[4] Daubert v. Merrell Dow Pharmaceuticals, Inc., 509 U.S. 579 (1993) (Supreme Court of the United States). The Court held that Rule 702 of the Federal Rules of Evidence requires trial judges to act as gatekeepers and assess the scientific reliability of expert testimony before it is admitted. The standard was extended to all expert testimony in Kumho Tire Co. v. Carmichael, 526 U.S. 137 (1999).

[5] R v. Otway [2011] EWCA Crim 3 (England and Wales Court of Appeal, Criminal Division). The Court of Appeal addressed the standards applicable to expert evidence in criminal proceedings in England and Wales, reinforcing the obligation on expert witnesses to clearly set out the basis of their opinion and acknowledge the limits of their expertise.

(iv) Hypothesis

This paper proceeds on five hypotheses.

- First, the scientific reliability of bite mark analysis is insufficient to sustain the evidentiary weight accorded to it by Indian courts, particularly in the absence of population-specific validation studies.
- Second, the admissibility provisions under the Indian Evidence Act and the BSA are structurally inadequate to enforce reliability-based gatekeeping of forensic expert evidence.
- Third, Indian courts, including the Supreme Court, have not applied consistent or sufficiently rigorous scientific standards in evaluating bite mark evidence.
- Fourth, advances in three-dimensional forensic imaging and artificial intelligence-assisted analysis, if properly institutionalised, could substantially improve the reliability of bite mark evidence.
- Fifth, a structured reform of admissibility standards informed by the Daubert model and tailored to Indian forensic and judicial capacity would significantly reduce the risk of wrongful convictions.

(v) Methodology

This research adopts a doctrinal analytical methodology supplemented by comparative legal analysis and forensic scientific literature review. The primary method involves systematic examination of legislation, judicial decisions, and scholarly commentary relating to forensic evidence and expert testimony. The study analyses *the Indian Evidence Act, 1872; the Bharatiya Sakshya Adhiniyam, 2023; the Bharatiya Nagarik Suraksha Sanhita, 2023;* and associated procedural codes. Case law from the Supreme Court and High Courts is subjected to textual analysis to identify evolving standards of admissibility and judicial reasoning.

Comparative legal analysis is employed with reference to the United States (Daubert standard and Federal Rules of Evidence), the United Kingdom (Criminal Procedure Rules and Law Commission recommendations), and Australia (uniform evidence legislation). Scientific literature from peer-reviewed journals including the Journal of Forensic Sciences, the International Journal of Legal Medicine, and Forensic Science International is reviewed to assess the current state of knowledge on bite mark reliability. The study does not involve primary data collection or experimental work; it is entirely based on secondary sources and its

analysis is qualitative and jurisprudential.

(vi) Limitations

This research is doctrinal in nature and does not include empirical data collection from courtrooms or forensic laboratories. Case law analysis is limited to reported and published judgments; unreported decisions and trial court rulings are largely inaccessible. The forensic scientific literature reviewed is primarily from international sources, as India-specific empirical studies on bite mark analysis remain scarce, requiring some extrapolation from international data. The new criminal justice codes enacted in 2023 are yet to receive substantial judicial interpretation, necessitating reliance on textual analysis and legislative intent in evaluating their practical operation. The study also does not assess the actual conduct of forensic experts in Indian courts or the functioning of forensic laboratories, as these matters require empirical fieldwork beyond the scope of this research.

(vii) Scheme of the Study

This paper is organised into an introduction followed by eight substantive sections comprising the present introductory framework and five thematic chapters examined across the body of the project.

- Chapter I examines the discipline of forensic odontology and the science of bite mark analysis, tracing its historical development, surveying the ABFO guidelines as the principal standard-setting framework, and evaluating the scientific community's critique most authoritatively articulated in the NAS Report (2009) and the PCAST Report (2016).
- Chapter II analyses the Indian legal framework governing expert evidence, including the provisions of the Indian Evidence Act, 1872, and their continuation and modification under the Bharatiya Sakshya Adhiniyam, 2023, with a comparative study of the Daubert standard and analogous English and Australian frameworks.
- Chapter III examines the judicial approach to bite mark evidence in India through analysis of Supreme Court and High Court decisions.
- Chapter IV evaluates the reliability of bite mark analysis from scientific and empirical perspectives relevant to the Indian context.
- Chapter V proposes a comprehensive reform framework for legislative, institutional, and procedural reform. The paper concludes with consolidated findings and

recommendations.

(viii) Literature Review

The existing body of scholarship on bite mark evidence and forensic odontology within the Indian legal context remains comparatively underdeveloped. This section surveys the most significant contributions across three streams of literature international scientific, Indian legal and forensic, and comparative legal scholarship and situates the present paper's contribution within that broader field of inquiry.

International Scientific Literature

The most authoritative scientific critique of bite mark analysis is contained in the *National Academy of Sciences Report, Strengthening Forensic Science in the United States: A Path Forward (2009)*[6]. This seminal publication, commissioned by the United States Congress, identified bite mark analysis as one of the forensic disciplines lacking adequate scientific foundation, specifically noting the absence of empirical studies establishing the uniqueness of human dentition and the reliability of human skin as an accurate recording medium. The report triggered widespread re-evaluation of forensic evidence standards across common law jurisdictions and remains the most consequential external challenge the discipline has faced.

The NAS findings were reinforced and extended by the *President's Council of Advisors on Science and Technology (PCAST) Report of 2016*[7]. PCAST concluded that bite mark analysis had not been demonstrated to be scientifically valid and recommended that courts should not admit it unless and until adequate validation studies had been conducted. Together, these reports shifted the burden of justification firmly onto proponents of bite mark evidence, with profound consequences for admissibility decisions in the United States most visibly through the post-conviction exonerations facilitated by the Innocence Project, where wrongfully convicted individuals have been freed following DNA-based review of cases in which bite mark testimony played a decisive role. Contemporary scientific studies have attempted to quantify the accuracy of bite mark analysis through controlled trials.

[6] National Academy of Sciences, Strengthening Forensic Science in the United States: A Path Forward, National Academies Press, Washington D.C., 2009 (ISBN 978-0-309-13130-5). The report was commissioned by the United States Congress and concluded that many forensic disciplines, including bite mark analysis, lacked the empirical foundation required for reliable use as criminal evidence.

[7] President's Council of Advisors on Science and Technology (PCAST), Forensic Science in Criminal Courts: Ensuring Scientific Validity of Feature-Comparison Methods, Executive Office of the President, Washington D.C., September 2016.

Research has reported substantially improved performance for three-dimensional methods achieving accuracy rates between 90% and 96% under standardised conditions compared with traditional two-dimensional overlay techniques, which typically yield sensitivity and specificity in the 60–75% range. Researchers have consistently cautioned, however, that laboratory conditions do not replicate the degraded and distorted bite marks encountered at actual crime scenes[8]. Methodological work on inter-examiner reliability employing the kappa coefficient of agreement and intraclass correlation coefficients has documented substantial variability among certified forensic odontologists reviewing identical cases, further undermining the claim of reproducible methodology.

Indian Legal and Forensic Literature

Within India, direct scholarly engagement with the evidentiary reliability of bite mark evidence is limited. The standard practitioner commentaries on the Indian Evidence Act most notably Sarkar's Law of Evidence and Ratanlal and Dhirajlal's treatment of expert evidence address the provisions governing expert opinion at a general level but do not engage with the contemporary scientific debates surrounding bite mark methodology. Texts on medical jurisprudence, including those by Modi, Mathiharan and Patnaik, discuss bite marks primarily from a clinical documentation perspective rather than an evidentiary reliability standpoint, reflecting the historical subservience of forensic odontology within the broader category of medical expert testimony in Indian legal practice[9].

More recent contributions from dental research institutions have begun to address this gap. Studies emanating from SDM College of Dental Sciences and the All India Institute of Medical Sciences have examined inter-examiner variability among Indian forensic odontologists, documenting significant concern regarding protocol inconsistency. The Indian Association of Forensic Odontology (IAFO) has advocated for standardised national protocols, but these recommendations have yet to receive formal legislative or judicial endorsement. From a law reform perspective, the Law Commission of India's reports on criminal procedure reform have touched upon the need for greater scrutiny of expert evidence generally, but none has

[8] See Thali, M.J., Braun, M. and Dirnhofer, R., "Optical 3D Digitizing of Bite Marks in Soft Tissue," Forensic Science International, Vol. 137, 2003, pp. 115–124; Bernitz, H. et al., "An Integrated Technique for the Analysis of Skin Bite Marks," Journal of Forensic Sciences, Vol. 53, 2008, pp. 194–198.

[9] Sarkar, S.C., Law of Evidence, 18th Edition, Wadhwa and Company, Nagpur, 2009. This is considered one of the most authoritative practitioner commentaries on the Indian Evidence Act, regularly cited by the Supreme Court of India.

specifically addressed bite mark analysis or other contested forensic disciplines[10].

The judicial contribution to this field, in India, takes the form of Supreme Court and High Court decisions in which bite mark evidence has featured. The Supreme Court's treatment of forensic evidence in *Selvi v. State of Karnataka (2010)*[11] where a constitutional bench undertook a rigorous scientific evaluation of narco-analysis and polygraph testimony before ruling on admissibility represents the standard of scrutiny that could and should be applied to bite mark analysis. The contrast between the rigour of Selvi and the relatively uncritical acceptance of bite mark testimony in cases such as *Mukesh & Anr. v. State for NCT of Delhi (2017)*[12] illustrates the inconsistency that characterises Indian jurisprudence on forensic evidence.

Comparative Legal Literature

International legal scholarship on bite mark admissibility is considerably more developed than its Indian counterpart. In the United States, D. Michael Risinger, David Faigman, Michael Saks, and Jay Aronson have written extensively on the problem of forensic science evidence and the inadequacies of reliability gatekeeping in courts[13]. Their work has directly influenced the reform discourse that produced the PCAST Report and the legislative discussions that followed. Saks and Faigman's critique of "pattern comparison" forensic disciplines of which bite mark analysis is a canonical example has been particularly influential in articulating the conceptual distinction between a forensic technique's intuitive plausibility and its empirical validation.

In the United Kingdom, Gary Edmond and colleagues have analysed the standards applied to expert forensic evidence in criminal proceedings, calling for greater judicial scrutiny consistent

[10] Indian Association of Forensic Odontology (IAFO). For published inter-examiner variability studies from Indian dental institutions, see publications in the Journal of Forensic Odontology and the Indian Journal of Forensic Medicine and Toxicology.
[11] Selvi v. State of Karnataka, (2010) 7 SCC 263 (Supreme Court of India). A three-judge constitutional bench ruled that compulsory administration of narco-analysis, polygraph, and BEAP tests violated Articles 20(3) and 21 of the Constitution. Significant for its rigorous evaluation of the scientific validity of forensic methodology prior to ruling on admissibility.
[12] Mukesh & Anr. v. State for NCT of Delhi & Ors., (2017) 6 SCC 1 (Nirbhaya Case). The Supreme Court upheld death sentences. Forensic evidence including bite mark testimony was admitted as corroborative without detailed scrutiny of the methodology's reliability.
[13] See Saks, M.J. and Faigman, D.L., "Failed Forensics: How Forensic Science Lost Its Way and How It Might Yet Find It," Annual Review of Law and Social Science, Vol. 4, 2008, pp. 149–171; Risinger, D.M., "Navigating Expert Reliability: Are Criminal Standards of Certainty Being Left on the Dock?", Albany Law Review, Vol. 64, 2000.

with scientific epistemology[14]. The Law Commission of England and Wales published a comprehensive report on expert evidence in criminal proceedings in 2011 (Law Com No. 325), recommending the adoption of a statutory reliability test.[15] While full legislative implementation has been gradual, the report has influenced the development of Criminal Procedure Rules that impose greater transparency obligations on expert witnesses requiring disclosure of the range of opinion on any relevant question and the basis for the expert's conclusion creating a degree of procedural scrutiny absent from the Indian framework.

In the Australian context, the uniform Evidence Acts operative in federal courts and most state jurisdictions render expert opinion evidence inadmissible unless it is based on specialised knowledge grounded in the expert's training, study, or experience. Australian courts have developed a body of jurisprudence applying this threshold that, while not as demanding as the Daubert test, provides a more structured framework for evaluating the scientific basis of expert testimony than the pure relevance test that governs Indian courts. The Australian model has been identified in comparative scholarship as a potential middle-path reformulation suitable for jurisdictions like India that seek greater reliability scrutiny without the wholesale adoption of the Daubert gatekeeping architecture.

This paper builds upon the surveyed literature by synthesising Indian case law, forensic scientific studies, and comparative legal scholarship to produce the first comprehensive legal assessment of bite mark evidence specifically tailored to the Indian context a contribution not yet provided within the existing body of scholarship. It proceeds, in the chapters and sections that follow, to develop this synthesis into a concrete reform agenda grounded in scientific evidence and comparative legal experience.

[14] Edmond, G. and Roach, K., A Contextual Approach to the Admissibility of the State's Forensic Science and Medical Evidence, Oxford University Press, 2011.
[15] Law Commission of England and Wales, Expert Evidence in Criminal Proceedings in England and Wales, Law Com No. 325, The Stationery Office, London, 2011.