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TOOLMARK COMPARISON

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CHAPTER I - INTRODUCTION AND RESEARCH FRAMEWORK

1.1 Introduction

Toolmark comparison is an important branch of forensic science that deals with the examination and comparison of marks left by tools when they come into contact with another surface during the commission of a crime[1571]. Such marks may be found on doors, windows, locks, metal sheets, wooden frames, bones, or other objects. Toolmark evidence is frequently encountered in cases of burglary, house-breaking, robbery, homicide, vandalism, and offences involving forced entry[1572].

[1571] Richard Saferstein, *Criminalistics: An Introduction to Forensic Science*, 12th ed. (Pearson Education, 2018), p. 165.
[1572] J.A. Siegel & P.J. Saukko (eds.), *Encyclopedia of Forensic Sciences*, Vol. III (Elsevier, 2013), pp. 420–423.

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In criminal investigations, toolmark comparison serves as associative evidence by linking a particular tool to a specific crime scene. Although tools are mass-produced, each tool acquires unique microscopic imperfections during manufacturing, use, wear, and damage. These imperfections are transferred to the surface upon contact, thereby enabling forensic experts to compare questioned toolmarks with test marks produced by suspected tools[1573].

In the Indian criminal justice system, toolmark comparison is treated as expert evidence. Courts rely on such evidence only when it is collected, preserved, and analysed using scientific methods and when the opinion of the expert inspires confidence. With the replacement of the Indian Evidence Act, 1872 by the Bharatiya Sakshya Adhiniyam, 2023, there is a renewed need to examine the legal position, admissibility, and probative value of toolmark comparison. This study attempts to analyse toolmark comparison from both forensic and legal perspectives, highlighting its relevance, challenges, and future potential.

1.2 Aim and Objectives of the Study

Aim of the Study:

The primary aim of this research is to critically examine the scientific principles, methods, and legal admissibility of toolmark comparison in the Indian criminal justice system[1574].

Objectives of the Study:

1. To understand the concept and nature of toolmarks and toolmark comparison.
2. To analyse the scientific principles underlying toolmark identification.
3. To examine the procedures involved in collection, preservation, and comparison of toolmarks.
4. To study the role of expert opinion in toolmark evidence.
5. To analyse the admissibility of toolmark evidence under the Bharatiya Sakshya Adhiniyam, 2023.
6. To examine the judicial approach of Indian courts towards toolmark evidence.
7. To identify limitations and challenges associated with toolmark comparison.
8. To suggest measures for improving the reliability and acceptance of toolmark evidence[1575].

1.3 Review of Literature

The scientific foundation of toolmark comparison has been discussed extensively in forensic literature. Hatcher, Jury, and Weller, in their seminal work on firearms and toolmark identification, emphasised that toolmarks possess both class and individual characteristics, making identification possible when sufficient individual characteristics are present. Paul L. Kirk highlighted the importance of proper collection and preservation to avoid contamination and distortion of toolmarks.

Saferstein, in his writings on criminalistics, pointed out that while toolmark comparison is a valuable forensic technique, it involves a degree of subjective interpretation, thereby necessitating strict laboratory standards and peer review. Recent forensic studies advocate the use of 3D imaging and computer-assisted comparison systems to enhance objectivity and reproducibility.

From a legal perspective, Ratanlal and Dhirajlal have analysed expert evidence in Indian courts, stressing that expert opinion is advisory in nature and must be corroborated by other evidence. Judicial pronouncements indicate cautious reliance on toolmark evidence, especially when it forms a crucial link in the chain of circumstantial evidence. However, there is limited Indian scholarly work specifically focusing on toolmark comparison under the

[1573] Hatcher, Jury & Weller, *Firearms Identification*, Vol. II (Stackpole Books, 1977), pp. 112–115.
[1574] K.I. Vibhute, *PSA Pillai's Criminal Law* (LexisNexis, 2022), p. 89.
[1575] Ratanlal & Dhirajlal, *The Law of Evidence*, 27th ed. (LexisNexis, 2024), pp. 523–525

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new evidentiary framework, highlighting the research gap addressed by this study.

1.4 Research Problem

Despite being a recognised forensic discipline, toolmark comparison faces several challenges in practice. The absence of uniform national standards, limited use of advanced technology, lack of specialised training, and the subjective nature of interpretation often lead to challenges regarding reliability and admissibility in courts. Moreover, inconsistent judicial appreciation of toolmark evidence creates uncertainty in its evidentiary value. These issues raise important questions about fairness, accuracy, and scientific validity in criminal trials.

1.5 Research Questions

The study seeks to answer the following research questions:

1. What are the scientific principles governing toolmark comparison?
2. How are toolmarks collected, preserved, and analysed in forensic practice?
3. What is the legal position regarding the admissibility of toolmark evidence in India?
4. How have Indian courts interpreted and relied upon toolmark expert evidence?
5. What are the limitations and challenges in the current practice of toolmark comparison?

1.6 Hypothesis

The study proceeds on the hypothesis that toolmark comparison is a reliable form of forensic evidence when conducted using standardised scientific methods and advanced technology and when supported by corroborative evidence[1576]; however, in the absence of such safeguards, its probative value is significantly reduced[1577].

1.7 Research Methodology

The present research adopts a **doctrinal research methodology**. The study is based on secondary sources, including:

- Statutory analysis of the Bharatiya Sakshya Adhiniyam, 2023, and related criminal laws
- Judicial decisions of the Supreme Court of India and various High Courts
- Standard forensic science textbooks and manuals
- Research articles, journals, and reports on forensic toolmark analysis

Analytical and descriptive methods have been employed to critically evaluate the legal and forensic aspects of toolmark comparison.

1.8 Scope and Limitations of the Study

Scope of the Study:

- The study focuses on toolmark comparison in criminal investigations.
- It examines the Indian legal framework with limited reference to international forensic practices.
- Emphasis is placed on expert evidence and judicial interpretation.

Limitations of the Study:

- The study does not include empirical or experimental laboratory research.
- Dependence is primarily on secondary sources.
- Practical constraints limit extensive comparative international analysis.

1.9 Scheme of the Study

The study is divided into five chapters:

- **Chapter I** deals with the introduction, research framework, and methodology of the study.
- **Chapter II** discusses the scientific principles of toolmark comparison and the types of toolmarks.

[1576] Richard Saferstein, *Criminalistics: An Introduction to Forensic Science*, 12th ed. (Pearson Education, 2018), pp. 170–172; Hatcher, Jury & Weller, *Firearms Identification*, Vol. II (Stackpole Books, 1977), pp. 118–120.
[1577] *Magan Bihari Lal v. State of Punjab*, AIR 1977 SC 1091; *State of Maharashtra v. Mohd. Yakub*, (1980) 3 SCC 57.

- **Chapter III** analyses the methods of collection, preservation, and comparison of toolmarks, including modern techniques.
- **Chapter IV** examines the legal admissibility of toolmark evidence and the judicial approach in India.
- **Chapter V** contains the findings, suggestions, and conclusion of the study.

CHAPTER II - SCIENTIFIC PRINCIPLES AND TYPES OF TOOLMARKS

2.1 Concept of Toolmarks

A toolmark refers to any impression, cut, scrape, gouge, or abrasion produced when a tool comes into contact with another object[1578]. Toolmarks are generally created when a harder object (tool) acts upon a softer surface (substrate). The resulting mark may retain microscopic features of the tool, which can later be examined for identification purposes[1579].

Toolmarks are commonly encountered on materials such as wood, metal, plastic, glass, bone, and paint. In criminal investigations, these marks often indicate forced entry, violence, or tampering, thereby providing crucial associative evidence.

2.2 Principle of Individuality in Toolmark Comparison

The foundation of toolmark comparison lies in the **principle of individuality**, which asserts that no two tools are identical[1580]. Although tools may be mass-produced, each tool acquires unique microscopic characteristics during manufacturing, usage, wear, corrosion, sharpening, and accidental damage. These random imperfections are transferred onto the surface during contact.

This principle is analogous to the individuality of fingerprints and firearms. The uniqueness of these microscopic features enables forensic experts to associate a particular tool with a questioned mark when sufficient correspondence is observed.

2.3 Class Characteristics

Class characteristics are features shared by a group of tools and arise from the manufacturing process. These characteristics allow an examiner to narrow down the category or type of tool responsible for producing a mark.

Examples of class characteristics include:

- Width and shape of a screwdriver blade
- Type of cutting edge (single-edged or double-edged)
- Size and curvature of a crowbar
- Number of teeth on a saw

Class characteristics alone cannot establish individual identification but are useful for elimination and classification purposes.

2.4 Individual Characteristics

Individual characteristics are random, accidental imperfections unique to a specific tool. These characteristics arise due to:

- Manufacturing defects
- Wear and tear during use
- Chipping, nicking, or corrosion
- Improper sharpening or damage

It is the correspondence of these individual characteristics between the questioned toolmark and the test mark that forms the basis of positive toolmark identification[1581].

2.5 Types of Toolmarks

Toolmarks are broadly classified based on the nature of contact between the tool and the surface[1582].

[1578] Richard Saferstein, *Criminalistics: An Introduction to Forensic Science*, 12th ed. (Pearson, 2018), p. 165.
[1579] Paul L. Kirk, *Crime Investigation: Physical Evidence and the Police Laboratory* (Interscience, 1974), p. 212.
[1580] Hatcher, Jury & Weller, *Firearms Identification*, Vol. II (Stackpole Books, 1977), pp. 110–112.
[1581] Hatcher, Jury & Weller, *Firearms Identification*, p. 118.
[1582] Saferstein, *Criminalistics*, p. 169.

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2.5.1 Impression Toolmarks

Impression toolmarks are produced when a tool is pressed against a surface without significant lateral movement. These marks reproduce the shape and surface features of the tool.

Examples include:

- Hammer impressions on bone or metal
- Pliers marks on wire
- Crowbar impressions on door frames

Impression toolmarks are particularly valuable as they often retain three-dimensional details of the tool[1583].

2.5.2 Striated Toolmarks

Striated toolmarks are produced when a tool moves across a surface, creating parallel lines or striations. These striations reflect the microscopic irregularities present on the tool's surface.

Examples include:

- Screwdriver pry marks
- Knife scraping marks on metal
- Saw marks on wood or bone

Striated toolmarks are commonly examined using comparison microscopes[1584].

2.5.3 Combination Toolmarks

Combination toolmarks exhibit both impression and striation characteristics. Such marks are frequently encountered in forced-entry cases where a tool is both pressed and dragged across a surface[1585].

2.6 Substrates and Their Influence on Toolmarks

The nature of the substrate plays a crucial role in the quality of toolmarks. Softer substrates tend to preserve tool characteristics better than harder materials. Factors influencing toolmark quality include:

- Hardness and elasticity of the substrate
- Angle and force of application
- Condition of the tool
- Environmental exposure

Understanding substrate behaviour is essential for accurate interpretation and comparison[1586].

2.7 Reproducibility of Toolmarks

One of the challenges in toolmark comparison is the issue of reproducibility. The same tool may not produce identical marks every time due to variations in pressure, angle, and movement. Therefore, forensic experts rely on sufficient agreement rather than exact duplication when comparing toolmarks[1587].

2.8 Significance of Scientific Principles in Legal Context

The scientific principles discussed in this chapter form the basis upon which courts assess the credibility of toolmark evidence. Judges rely on expert testimony to explain class and individual characteristics, the principle of individuality, and the limitations of comparison. A clear understanding of these principles ensures that toolmark evidence is not overstated and is evaluated fairly in criminal trials.

CHAPTER III - COLLECTION, PRESERVATION, AND TOOLMARK COMPARISON TECHNIQUES

3.1 Collection of Toolmark Evidence at the Crime Scene

The collection of toolmark evidence begins at the crime scene and requires careful observation, documentation, and protection of marks. Toolmarks are often fragile and easily altered by environmental factors or human interference.

Key steps in the collection include:

- Identification of potential toolmarks on doors, windows, locks, floors, furniture, weapons, or human remains.

[1583] Paul L. Kirk, *Crime Investigation*, p. 215.
[1584] Richard Saferstein, *Criminalistics*, p. 171.
[1585] Hatcher, Jury & Weller, *Firearms Identification*, p. 121.
[1586] AFTE Theory of Identification, *Journal of Forensic Sciences*, Vol. 30 (1985).
[1587] *Magan Bihari Lal v. State of Punjab*, AIR 1977 SC 1091.

- Securing the scene to prevent further damage.
- Avoiding direct contact with the toolmark surface.

Investigators must recognise that toolmark evidence is time-sensitive and should be prioritised during scene processing.

3.2 Documentation and Photography of Toolmarks

Proper documentation is essential before any attempt is made to remove or cast a toolmark.

- Toolmarks should be photographed using high-resolution cameras.
- A measurement scale must be included in all photographs.
- Oblique and side lighting should be used to highlight striations and impressions.
- Multiple angles should be recorded.

Photographic documentation serves as a permanent record and aids both laboratory analysis and courtroom presentation[1588].

3.3 Preservation and Packaging of Toolmark Evidence

Once documented, toolmarks must be preserved in a manner that prevents alteration.

- If possible, the entire object bearing the toolmark should be removed and packaged.
- Objects should be wrapped individually to prevent friction.
- Soft padding materials should be used.
- Moisture and extreme temperatures should be avoided.

Maintaining the **chain of custody** is crucial to ensure the integrity and admissibility of evidence[1589].

3.4 Casting of Toolmarks

In situations where removal of the marked object is not feasible, casting becomes essential.

Common casting materials include:

- Silicone rubber compounds
- Dental stone or plaster

Casting must be carried out carefully to ensure accurate reproduction of microscopic details. A well-prepared cast often provides better examination conditions than the original surface.

3.5 Collection and Handling of Suspected Tools

Suspected tools recovered from the accused or nearby locations must be handled with extreme caution.

- Tools should not be cleaned, wiped, or altered.
- Each tool must be packaged separately.
- Tools should be labelled and sealed properly.

The condition of the tool at the time of recovery is critical for meaningful comparison[1590].

3.6 Production of Test Toolmarks

Test toolmarks are produced in the laboratory using the suspected tool.

- Test marks should be created on substrates similar to the questioned surface.
- Multiple test marks should be produced to account for variation.
- Controlled conditions of pressure and angle should be maintained[1591].

These test marks form the basis for comparison with questioned toolmarks.

[1588] J.A. Siegel & P.J. Saukko (eds.), *Encyclopedia of Forensic Sciences*, Vol. III (Elsevier, 2013), p. 425.
[1589] *State of Rajasthan v. Kashi Ram*, (2006) 12 SCC 254.
[1590] Hatcher, Jury & Weller, *Firearms Identification*, Vol. II (Stackpole Books, 1977), p. 124.
[1591] Saferstein, *Criminalistics*, p. 176.

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3.7 Toolmark Comparison Techniques

3.7.1 Visual Examination

Initial examination is conducted with the naked eye or low-power magnification to assess class characteristics and suitability for comparison[1592].

3.7.2 Comparison Microscope Examination

The comparison microscope is the primary instrument used in toolmark analysis.

- It allows simultaneous viewing of questioned and test marks.
- Examiners compare striation patterns and impressions side-by-side.
- Identification is based on sufficient agreement of individual characteristics[1593].

3.7.3 Stereomicroscopy

Stereomicroscopes provide three-dimensional visualisation and are particularly useful for impression toolmarks.

3.8 Advanced and Modern Techniques in Toolmark Comparison

With technological advancement, traditional subjective methods are being supplemented by objective and computer-assisted techniques.

- **3D surface topography analysis**
- **Confocal microscopy**
- **Scanning Electron Microscopy (SEM)**
- **Automated Toolmark Identification Systems (ATIS)**
- **Digital imaging and algorithm-based comparison**

These techniques enhance accuracy, reproducibility, and transparency in expert opinions.

3.9 Evaluation and Interpretation of Results

The conclusions in toolmark comparison are generally categorised as:

1. Identification
2. Elimination
3. Inconclusive
4. Unsuitable for comparison

Experts must avoid claims of absolute certainty and clearly explain the basis of their conclusions.

3.10 Challenges in Toolmark Comparison Practice

- Variability in toolmark reproduction
- Tool wear or alteration after the crime
- Poor quality or damaged marks
- Examiner bias and subjectivity

These challenges necessitate cautious interpretation and corroboration[1594].

CHAPTER IV – LEGAL ADMISSIBILITY OF TOOLMARK EVIDENCE AND JUDICIAL APPROACH IN INDIA

4.1 Toolmark Evidence as Expert Evidence

Toolmark comparison falls within the category of **expert evidence**, as it involves specialised scientific knowledge beyond the understanding of ordinary persons[1595]. Courts rely on forensic experts to explain the scientific basis of toolmark identification, comparison techniques, and the significance of matching characteristics.

Expert evidence is advisory in nature and does not bind the court. The probative value of such evidence depends on the credibility of the expert, the methodology adopted, and the manner in which conclusions are presented.

[1592] J.E. Starrs, *Scientific Evidence in Criminal Cases* (West Publishing, 2007), p. 392.

[1593] AFTE Theory of Identification, *Journal of Forensic Sciences*, Vol. 30 (1985), pp. 86–92.

[1594] NAS Report (2009), p. 156.

[1595] Bharatiya Sakshya Adhiniyam, 2023, s. 39.

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4.2 Bharatiya Sakshya Adhiniyam, 2023, and Toolmark Evidence

The Bharatiya Sakshya Adhiniyam, 2023, governs the admissibility of expert opinion in criminal trials.

- **Section 39** recognises the relevance of expert opinion when the court has to form an opinion on matters of science, art, or specialised skill.
- Forensic experts, including toolmark analysts, fall within the scope of this provision.

The Act emphasises reliability, relevance, and procedural fairness. Courts are empowered to examine the scientific basis of the expert's opinion and the conditions under which the evidence was obtained[1596].

4.3 Conditions for Admissibility of Toolmark Evidence

Indian courts generally consider the following factors while admitting and relying upon toolmark evidence:

1. Qualifications and experience of the expert
2. Proper collection and preservation of toolmark evidence
3. Maintenance of an unbroken chain of custody
4. Use of recognised and standard scientific methods
5. Corroboration with other evidence[1597]

Failure to satisfy these conditions may weaken or nullify the evidentiary value of toolmark comparison.

4.4 Judicial Approach Towards Toolmark Evidence

Indian courts have consistently held that expert evidence must be approached with caution. Toolmark evidence is rarely accepted as the sole basis for conviction and generally requires corroboration.

In **Magan Bihari Lal v. State of Punjab**, the Supreme Court held that expert opinion is only advisory and should not be accepted blindly. Similarly, in **Ram Chandra v. State of Uttar Pradesh**, the Court accepted tool and weapon comparison evidence when supported by other circumstances.

4.5 Constitutional and Fair Trial Considerations

The admissibility of toolmark evidence must also satisfy constitutional guarantees under Article 21 of the Constitution of India. Scientific evidence that is unreliable, improperly collected, or inadequately explained may violate the accused's right to a fair trial[1598].

Courts must ensure that expert evidence does not prejudice the accused and that adequate opportunity is provided for cross-examination of experts.

4.6 Evidentiary Value and Limitations in Judicial Practice

Despite its usefulness, toolmark evidence faces judicial scepticism due to:

- Subjectivity in interpretation
- Absence of quantified error rates
- Variations in laboratory standards[1599]

Judicial awareness of these limitations has resulted in cautious and balanced evaluation.

CHAPTER V – FINDINGS, SUGGESTIONS, AND CONCLUSION

5.1 Findings of the Study

The study reveals that toolmark comparison is a valuable forensic technique capable of providing significant associative evidence in criminal investigations[1600]. The principle of individuality forms the scientific foundation of

[1596] Law Commission of India, 277th Report on Evidence Law Reforms (2023), para 6.4.
[1597] *State of Rajasthan v. Kashi Ram*, (2006) 12 SCC 254.
[1598] *Ram Narain Singh v. State of Punjab*, AIR 1975 SC 1727.
[1599] National Academy of Sciences, *Strengthening Forensic Science in the United States: A Path Forward* (2009), p. 154.
[1600] Richard Saferstein, *Criminalistics: An Introduction to Forensic Science*, 12th ed. (Pearson, 2018), p. 165.

toolmark identification[1601]. However, the reliability of such evidence depends heavily on proper collection, preservation, expert competence, and the use of standardised methods.Judicial decisions indicate that Indian courts recognise toolmark evidence but approach it with caution. Toolmark comparison is rarely treated as conclusive and is generally relied upon only when corroborated by other evidence.

5.2 Suggestions and Recommendations

1. Adoption of uniform national standards for toolmark examination
2. Increased use of advanced technologies such as 3D imaging and automated systems
3. Regular training and proficiency testing for forensic toolmark examiners
4. Development of clear guidelines for presentation of toolmark evidence in courts
5. Enhanced judicial training on forensic science and expert evidence

5.3 Conclusion

Toolmark comparison occupies an important place in forensic science and criminal adjudication. When conducted scientifically and evaluated judiciously, it can assist courts in uncovering the truth and delivering justice. However, its subjective elements and procedural vulnerabilities necessitate cautious judicial reliance[1602].

The Bharatiya Sakshya Adhiniyam, 2023 provides a renewed framework for assessing expert evidence, including toolmark comparison. Strengthening forensic infrastructure, standardising practices, and fostering judicial–scientific dialogue will enhance the credibility and utility of toolmark evidence, thereby contributing to fair trials and effective criminal justice administration.

[1601] Hatcher, Jury & Weller, *Firearms Identification*, Vol. II (Stackpole Books, 1977), pp. 110–112.
[1602] *Ramesh Chandra Agrawal v. Regency Hospital Ltd.*, (2009) 9 SCC 709.