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A Review based on the forensic techniques used in obliterated marks and firearm injuries

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ABSTRACT

Forensic science is a multidisciplinary discipline central to criminal case investigation and resolution. Among its numerous applications, firearm-related forensic examination is of outstanding significance because of the prevalence of gun crimes. This article provides a comprehensive overview of the types and forensic significance of firearm injuries and erased marks on firearms, including classical and contemporary investigative methods. Through the critical examination of recent literature, experimental evidence, and technological advances, this review seeks to clarify these major forensic areas and their contribution to contemporary criminal investigations.

Keyword: Firearm injuries, Obliterated marks, types, investigation and forensic techniques.

INTRODUCTION

Forensic science plays a crucial role in bridging the gap between crime and justice, helping investigators uncover critical information from even the smallest pieces of evidence. Among the most significant types of evidence analysed in forensic investigations are firearm injuries and obliterated marks. Firearm injuries, caused by projectiles such as bullets or pellets, provide valuable insights into various factors such as the type of weapon used, the distance between the victim and the shooter, and the direction of fire. In contrast, obliterated marks-often intentionally removed or altered serial numbers-pose significant challenges for forensic experts attempting to trace stolen or illegal firearms. This review focuses on the examination and analysis of both firearm injuries and obliterated marks, highlighting the various forensic techniques employed to address these challenges. Firearm injuries can be classified into different categories depending on the range from which the shot was fired. Contact wounds occur when the muzzle is in direct contact with the body, often leading to characteristic marks such as muzzle imprints and skin charring. Close-range wounds, on the other hand, show signs of unburnt gunpowder particles embedded in the skin, a phenomenon known as gunpowder tattooing or stippling. Intermediate-range wounds exhibit similar stippling but lack the other distinctive features, while distant-range wounds typically show only the entry wound with no visible signs of burning or stippling. The forensic significance of firearm injuries lies in their ability to help investigators estimate the range from which the shot was fired, determine the type and caliber of the weapon used, and reconstruct the sequence of events surrounding the shooting.

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Obliterated marks, such as tampered or erased serial numbers, present a different challenge in forensic investigations. These marks are often intentionally removed to hinder the identification of stolen firearms or tools. Various methods of obliteration exist, including scratching or filing away engraved numbers, using tools to punch or deform the surface, and grinding off serial numbers with abrasives or chemicals. In forensic practice, restoring these marks is crucial for identifying the original owner of a weapon or linking it to criminal activity. Several techniques are used to restore obliterated marks, including magnetic particle inspection, chemical etching, ultrasonic testing, and digital enhancement. Each of these methods has its strengths and limitations, depending on the nature of the obliteration and the materials involved.

Both firearm injuries and obliterated marks require specialized forensic techniques for proper analysis. For firearm injuries, forensic ballistics, gunshot residue (GSR) testing, and advanced imaging techniques such as CT scans play an essential role in identifying key details about the shooting incident. For obliterated marks, techniques like chemical etching and digital enhancement are particularly valuable for revealing hidden serial numbers. As forensic science continues to advance, these techniques are increasingly being integrated to offer more accurate, non-destructive methods for evidence analysis, helping ensure that justice is served through the careful interpretation of forensic evidence.

LITERATURE REVIEW

Many studies and reports have pointed out serious problems in how forensic work is conducted in India.

As per author Kaufman E. et al. (2021) discussed in the paper in US firearm injury studies have emphasized fatal injuries. Nonfatal firearm injuries and their associated epidemiologic factors and incidence are less well known. To compare estimates of the incidence and trends over time of fatal and nonfatal firearm injuries. Firearm injuries coded using International Classification of Diseases external cause of injury codes and classified by intent of injury, age category, and urban-rural area. Main and Measures Incidence, case fatality rate, and time trends of firearm injury by intent, age group, and urban-rural residence.[1]

Toshal and Binay (2024) discuss in the paper that misinterpretation of a gunshot injury by a non-forensic medicine expert and has provided the case report of misguidance in the criminal investigation involving the unusual firearm injury 'kronlein shot'. [2]

As per the author V Husieva (2021) studied about the analysis of investigative and judicial experience as well as the works of Ukrainian and foreign researchers, the study aims to ascertain the average strategic tasks that must be completed at the outset of the investigation of murders involving firearms, as well as the specific characteristics of their realization. According to the statement, these include determining the identity of the victim, the type of criminal offense, the location and time of the offense, the method used to commit the offense, researching crime weapon; determining the offender's identity and the reasons behind their actions. [3]

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According to the author Vaishali Goud and Kajol Bhati (2022) discussed about the study of the restoration of obliterated marks on serial number on keys with the help of various chemical etching methods on the various surfaces such as metal, steel, leather, zinc etc. [4]

METHODOLGY

The overall design of this study was exploratory. This study employed a positivistic and interpretive research paradigm based on observation and text analysis. This study took a critical perspective toward all the existing towards the topic A Review based on the forensic methods applied to eradicated marks and gun injuries, and the laws of India, and other nations. The major theoretical premise of this thesis was a discussion on how the study is conducted for engraved obliterated marks and gun injury.

In order to write this article, I only utilized the already available information. I have read journal articles, government reports, and actual case studies published between 2021 and 2024 very carefully. I utilized a step-by-step review process to gather, verify, and comprehend all the significant sources. For writing this review, I utilized google scholar, peer-reviewed, academia, and other sources to retrieve information. It is limited to secondary data and does not include primary interviews or field observations. It may compromise on the depth of insight into existing forensic practice on the ground.

DISCUSSION

Forensic science has advanced significantly over the years, particularly in the analysis of firearm injuries and obliterated marks. One key challenge in both areas is the need for reliable and accurate methods to extract information from damaged or altered evidence. Firearm injury analysis is a crucial component of reconstructing shooting incidents. The techniques used, such as forensic ballistics and gunshot residue (GSR) testing, provide valuable insights into the nature of the injury and the circumstances surrounding the crime. For instance, GSR testing can determine whether a suspect was involved in a shooting incident by detecting particles of unburnt gunpowder, while forensic ballistics can identify the type and caliber of the weapon used. These methods, when used together, help forensic experts reconstruct the sequence of events and provide critical evidence in criminal cases.

In the case of obliterated marks, the forensic community faces the challenge of recovering altered or removed serial numbers from firearms or tools. Traditional methods such as chemical etching, while effective, often pose a risk of permanently damaging the evidence. This limitation has driven the development of non-destructive techniques like 3D laser scanning and digital enhancement. 3D laser scanning, in particular, offers a promising approach to restoring serial numbers without compromising the integrity of the object. These modern methods allow forensic experts to recover hidden details and maintain the original evidence, making them invaluable tools in investigations involving tampered firearms or tools.

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Despite the advancements in forensic technology, practical challenges remain in the field. One of the primary obstacles is the accessibility of advanced equipment. Techniques such as SEM-EDX for GSR analysis and 3D laser scanning require specialized equipment that may not be available in all forensic labs, particularly in resource-limited settings. Additionally, the high costs associated with these methods can limit their widespread use. Furthermore, the need for skilled personnel to operate complex equipment remains a barrier in many regions. Forensic professionals must be trained in these new technologies to ensure their effective application in criminal investigations.

Finally, the integration of various forensic methods into a cohesive investigative approach is essential for accurate and comprehensive results. Relying on a single technique may not provide enough information to conclusively solve a case. Instead, combining multiple methods, such as ballistic analysis, GSR testing, and serial number restoration, can significantly enhance the reliability of forensic evidence. Case studies have shown that when different forensic techniques are used together, they lead to more robust conclusions, increasing the chances of identifying perpetrators and ensuring justice. As forensic science continues to evolve, it is crucial to invest in the development of new technologies, improve training, and ensure that these methods are accessible to all forensic labs, regardless of their resources.

CONCLUSION

In summary, forensic methods employed to examine firearm wounds and erased marks are crucial instruments in seeking justice. Firearm wound classification and analysis deliver essential information on shooting dynamics, while obliterated mark restoration allows firearm tracing. Advanced methods such as 3D imaging, chemical testing, and AI-facilitated diagnostics are heightening the accuracy and dependability of such examinations. A combination strategy that incorporates both conventional methods and new technologies guarantees ongoing development of forensic science.

The examination of firearm injuries and obliterated marks is a critical component of forensic investigations. While traditional methods such as chemical etching and ballistic analysis remain important, technological advancements like digital enhancement and 3D laser scanning offer new possibilities for accurate evidence restoration. This review emphasizes that a multidisciplinary approach, incorporating both established and emerging techniques, is essential for improving forensic outcomes. Ongoing research, along with better infrastructure and training, is necessary to address the growing complexity of forensic cases.

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