InSight Bulletin: A Multidisciplinary Interlink International Research Journal
Peer Reviewed International, Open Access Journal.
ISSN : 3065-7857 / Website: https://ibrj.us / Volume-2, Issue-7 / July - 2025

Original Article

Forensic Challenges in the Examination of Country-Made Firearms: A Forensic Approach

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Manuscript ID:
IBMIIRJ -2025-020713

Submitted: 10 June 2025

Revised: 27 June 2025

Accepted: 15 July 2025

Published: 31 July 2025

ISSN: 3065-7857

Volume-2

Issue-7

Pp. 60-63

July 2025

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Quick Response Code:

Web. https://ibrj.us

DOI: 10.5281/zenodo.17045677

DOI Link:
https://doi.org/10.5281/zenodo.17045677

Abstract

The increasing proliferation of country-made firearms in India presents a serious challenge for forensic science and law enforcement. According to the National Crime Records Bureau, 97% of the firearms seized in 2022 were unlicensed, improvised, or locally manufactured, highlighting the dominance of crude weapons in criminal activities. Unlike factory-produced arms, country- made firearms lack rifling, serial numbers, and standardized construction, which severely limits conventional ballistic examination and traceability. These weapons are often made from recycled materials, employ variable ammunition, and function with poor accuracy, frequently allowing only single-shot firing. Forensic ballistics analysis—including internal, external, and terminal studies—faces added complexity due to unpredictable pressure, unstable projectile trajectories, and atypical wound patterns. Evidence recovery is further hindered by deformed bullets, non- standard ammunition, and the risks associated with test-firing unstable firearms. Additionally, the absence of dedicated forensic databases for improvised weapons restricts cross-case linkages.

To address these limitations, there is an urgent need for alternative forensic methodologies, enhanced documentation standards, and specialized databases for non-standard firearms. Strengthening such approaches will not only improve the reliability of ballistic investigations but also contribute significantly to effective crime-solving and judicial outcomes in firearm-related cases.

Keywords *– Ballistics, Country-made firearms, Improvised firearms.*

Introduction

According to the annual report of the National Crime Records Bureau (NCRB) there is a proliferation in the use and production of country-made firearms across India. In comparison to cases registered under the Arms Act during 2021, the year 2022 witnessed a rise, with more cases registered. During this period, law enforcement agencies seized a total of 104,390 firearms [1]. Of these, only 3,609 were factory-made or licensed weapons, and the rest, that is, 100,781, were country-made, unlicensed, or improvised weapons. That means 97% of country-made firearms were seized. Based otherwise rate, India is at the 77th position globally [2]. Firearms are commonly encountered in violent crimes, with forensic ballistics playing a key role in linking bullets, weapons, and suspects. While forensic firearm analysis is well-established for factory-made guns, the increasing prevalence of country-made firearms—also known as improvised or crude firearms—demands new forensic approaches. These weapons are often manufactured illegally with easily available materials and do not follow ballistic norms, posing serious challenges in evidence recovery, matching, and legal prosecution [3, 4].

Characteristics of Country-Made Firearms

The forensic profiling of country-made firearms is crucial for understanding their structural features, operational mechanisms, and ballistic behavior because of the following reasons:

1Crude Construction- Such muzzle-loading firearms are usually constructed using improvised or recycled materials like scrap iron, wood, or iron pipes. Due to their irregular designs and coarse finishing, it becomes difficult to identify their impressions or tool marks [5].

2 Absence of Serial Numbers or Markings- Most of the country-made firearms are produced without serial numbers, proof marks, and any distinguishing manufacturing stamps, making it extremely difficult to trace their source. But nowadays, during the examination of such kinds of firearms, it is visible that in some firearms, some specific mark is there, like “made in USA”,

How to cite this article:
Shil, S., & Pal, A. (2025). Forensic Challenges in the Examination of Country-Made Firearms: A Forensic Approach. Insight Bulletin: A Multidisciplinary Interlink International Research Journal, 2(7), 60–63. https://doi.org/10.5281/zenodo.17045677

"Auto 7.65", etc. With the help of this, it is possible to identify the region from where it came [6].

3 Lack of Rifling -Muzzle-loaders are smoothbore, hence this is difficult to compare between two ammunition. This prevents forensic experts from gaining class or individual traits like striation marks on bullets, whichare integral to ballistic examination [7].

4 Ammunition Variability- Most of the time in muzzle loading firearms homemade ammunition tends to be used like metallic pieces, net sinkers, etc. and thus test firing is unsafe and unpredictable by these firearms [8].**5 Inaccurate Shooting**: These firearms often miss the target because they are made without proper alignment or detailed craftsmanship. The
Aim tends to be off, and bullets may not follow a straight path [9].

6 One-Time Firing: Most of these weapons can only fire one bullet at a time. After that, they must be reloaded manually, as they don't have advanced features like magazines or automatic reloading systems [10].

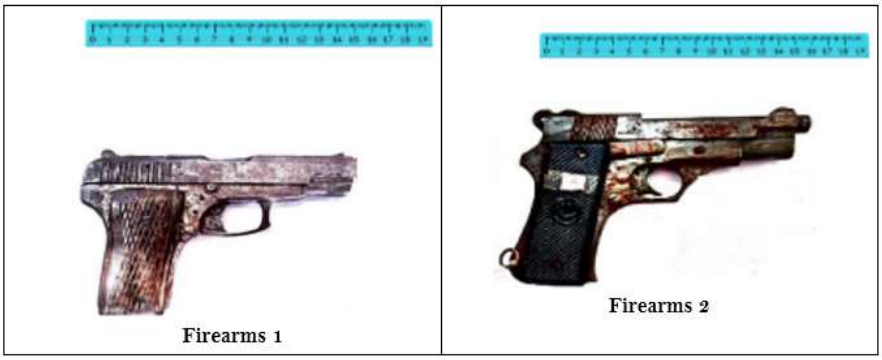

Figure 1: Photo of a seized country-made pistol (Source: Shil, Sourav, et al. "Investigation of country-made firearms in forensic relevance." *Interactions* 245.1 (2024): 280.)

Forensic Ballistics Analysis

1Internal Ballistics

Study of projectile movement inside the firearm. Crude weapons create unpredictable pressure and trajectory due to poorly constructed chambers.

2 External Ballistics

External ballistics deals with the behavior of a projectile in flight after it leaves the firearm barrel. Due to a lack of rifling, projectiles travel without spin, resulting in inaccurate flight paths and unstable trajectories.

3 Terminal Ballistics

Terminal ballistics focuses on how the projectile interacts with the target upon impact. Country-made guns typically fire low-velocity bullets. Wound patterns may be atypical. Sometimes, the projectile fragments on impact [11].

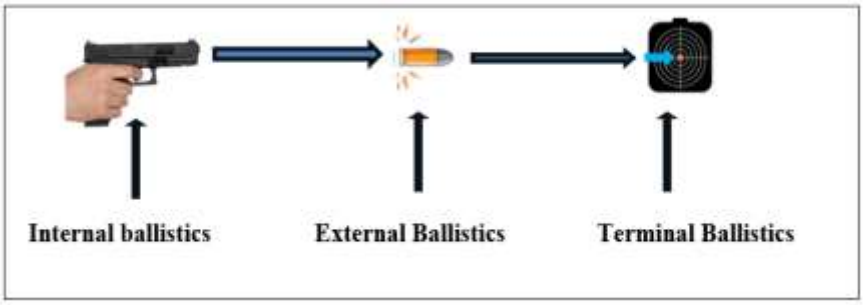

Figure 2:A figure depicting internal Ballistics, external Ballistics and terminal Ballistics.

Ballistic Evidence Collection

1 Weapons

Firearms discovered at a crime scene must be handled with extreme care to preserve their forensic value. The weapon should be secured in a safe condition—ideally without pulling the trigger, cycling the action, or otherwise disturbing the internal mechanisms. This precaution helps preserve any latent fingerprints, DNA evidence, or gunshot residue present on the firearm, as well as the condition of the firing pin, barrel, and chamber. If the weapon is loaded, it must be rendered safe by a qualified professional to prevent accidental discharge during transport or analysis [12].

2 Bullets and Casings

Spent bullets and cartridge casings recovered from a crime scene or autopsy are often misshapen, fragmented, or partially deformed due to impact. Despite this, forensic examiners still attempt to recover toolmarks left by the barrel (on bullets) and firing pin, breech face, or extractor (on casings). These microscopic markings can sometimes link a bullet or casing to a specific firearm. However, excessive damage can limit the potential for direct comparison, requiring analysts to rely on partial markings or combine findings with other forensic evidence [13].

3 Test Firing

Before a firearm can be test-fired for forensic analysis, it must first be confirmed as safe to operate. In cases where the weapon is damaged or old, experts may need to construct custom mounts or jigs to securely hold the firearm during firing. The purpose of test firing is to obtain fresh bullets and casings with clear toolmarks for comparison to evidence recovered from the scene. These samples are then analysed under a comparison microscope to look for unique striations or impressions [14].

4 Residue Collection (GSR Testing)

Gunshot residue (GSR) analysis plays a critical role in ballistic investigations, especially when no bullets or casings are recovered, or when markings are too degraded for traditional comparison. GSR consists of microscopic particles expelled when a firearm is discharged, typically containing elements such as lead, antimony, and barium. These particles can settle on the shooter's hands, clothing, or nearby surfaces. Swabbing is usually conducted as soon as possible after the incident—ideally within 4–6 hours—because residue can be easily lost through movement or washing. GSR testing helps determine whether a suspect recently fired a weapon or was near a discharge event, making it a key tool in reconstructing events and corroborating witness statements [15].

Challenges in Forensic Examination

1 No Rifling

In forensic ballistics, rifling refers to the spiral grooves cut into the barrel of a firearm. These grooves impart a spin to the bullet, stabilizing its flight and leaving unique markings on the projectile's surface. These marks can be compared to test bullets fired from a suspect weapon. However, in the case of smoothbore firearms—such as shotguns or crude, locally manufactured guns—there is no rifling. Without rifling, bullets are not imprinted with distinctive markings, making it impossible to link them to a specific firearm through traditional ballistic comparison [16].

2 Modified or Non-Standard Ammunition

In many criminal cases, investigators encounter altered or homemade ammunition that does not conform to factory specifications. This includes hand-loaded cartridges, re-used casings, or ammunition assembled using improvised materials. Such modifications can affect how the firearm operates and can produce inconsistent or unclear markings on bullets and casings. This irregularity complicates the forensic examination process and can reduce the reliability of ballistic matches [17].

3 Dangerous to Test-Fire

Certain firearms—especially older models, homemade guns, or those in poor condition—pose significant risks when being test-fired. The structural integrity of these weapons may be compromised, increasing the likelihood of accidental discharge, misfire, or even explosion during testing [18].

4 Lack of forensic databases for country-made weapons

Many countries maintain computerized databases of ballistic signatures—such as the Integrated Ballistics Identification System (IBIS)—which store digital images of bullets and casings for comparison across cases. However, these databases are generally built around factory-produced firearms. Crude or country-made weapons often fall outside this framework, as they are not cataloged and may lack standardized components. As a result, investigators have fewer resources to cross-reference evidence when such weapons are involved, hindering efforts to trace firearms or link cases together [19].

Conclusion

The proliferation of country-made firearms in India, as highlighted by the NCRB data, poses significant challenges to both law enforcement and forensic investigators. With 97% of seized firearms being unlicensed, improvised, or country-made, the traditional forensic frameworks designed for factory-manufactured weapons are increasingly becoming inadequate. These crude weapons often lack rifling, serial numbers, and consistent construction standards, making ballistic matching and traceability highly difficult. Moreover, the frequent use of modified or homemade ammunition, coupled with the inherent dangers of test-firing unstable weapons, further complicates forensic examination. The forensic science community must also contend with the absence of specialized databases for such weapons, limiting investigative capabilities. Given these complexities, there is a pressing need for the development of new forensic methodologies tailored to the unique characteristics of country-made firearms. This includes improved documentation standards, alternative ballistic analysis techniques, and the creation of a dedicated database for non-standard weapons. Ultimately, strengthening the forensic response to these emerging threats is essential not only for solving violent crimes but also for enhancing public safety and judicial reliability in firearm-related prosecutions.

Acknowledgment

The authors would like to express their sincere gratitude to Lovely Professional University, Punjab, and the Tripura State Forensic Science Laboratory, Narsingarh, for providing academic support and encouragement during the preparation of this work. The guidance and insights from faculty members, colleagues, and experts in the field of forensic science have been invaluable in shaping the ideas presented in this paper. The authors also acknowledge with appreciation the use of published works and reports that have significantly contributed to the review and analysis. Finally, heartfelt thanks are extended to family and well-wishers for their constant motivation and encouragement throughout this endeavor.

Financial Support and Sponsorship

Nil

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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