Forensic Examination of Modified Rifled Firearm

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Abstract:
Illicit modification of factory-manufactured firearms has emerged as a significant challenge for forensic firearm examination, particularly when legally manufactured weapons are altered to chamber and fire unauthorized ammunition. This study aimed to investigate the mechanical alteration of a factory-made .303 British bolt-action rifle modified to chamber and discharge 7.62 × 51 mm cartridges, while evaluating its structural modifications, ballistic performance, and forensic significance. The firearm underwent detailed visual and mechanical examination, dimensional analysis of the chamber using a precision Vernier caliper, controlled test firing, muzzle velocity measurement using the BMS software, and forensic examination of fired cartridge cases. Comparative analyses were conducted with a standard .303 British rifle and a standard 7.62 × 51 mm self-loading rifle (SLR). Examination revealed that a metallic lining had been introduced at the shoulder-to-neck junction of the chamber, reducing its diameter to accommodate the smaller cartridge. Test firing confirmed the successful functioning of the modified firearm; however, it exhibited a substantially reduced muzzle velocity compared with the standard .303 British rifle and SLR. Fired cartridge cases also displayed characteristic bulging due to inadequate chamber support and abnormal pressure distribution. The findings demonstrate that localized chamber modifications can effectively convert a .303 British rifle to fire 7.62 × 51 mm ammunition, albeit with compromised ballistic performance and increased mechanical risk. The study highlights the forensic importance of dimensional chamber analysis, ballistic testing, and fired cartridge case examination in identifying illegally modified firearms, thereby providing valuable scientific evidence for forensic laboratories and law enforcement investigations.

Keywords: illicit firearm modification; forensic ballistics; .303 British rifle; 7.62 × 51 mm cartridge; chamber alteration; muzzle velocity; firearm identification; forensic firearm examination

1. Introduction:

Illicit alteration of legally manufactured firearms has become a significant problem for forensic firearm examination and law enforcement agencies worldwide. Instead of focusing solely on illicit manufacture or trafficking, offenders are starting to tamper with factory-produced weapons so that they can chamber and fire ammunition that was never meant to be used (Puri et al., 2019). In practice, this makes it easier to use older or surplus firearms because ammunition that is more common is available, and at the same time, it makes forensic work more difficult, including the identification of the firearm and even how cases are argued in court. Because these altered guns appear more frequently, there is a real need to

understand the structural changes being made, how they affect ballistic performance, and what forensic traits are observed (O'Keeffe et al., 2015).[1]
The .303 British bolt-action rifle, originally built to fire the .303 British cartridge, has seen widespread use in military and police services, and it is still in circulation in several countries (Lysiuk, 2022). Because surplus rifles are available, these weapons are frequently exposed to unauthorized mechanical alterations that allow them to fire newer rounds, such as the 7.62 × 51 mm ammunition, which is often associated with self-loading rifles (SLRs) (Jain et al., 2004). These kinds of changes do not just slightly tweak things — they shift the firearm's original chamber geometry and how the mechanism operates, essentially turning a legally made firearm into an illegally modified one that can shoot ammunition outside of its intended design limits (O'Keeffe et al., 2015). In addition to breaking legal requirements, such alterations can also undermine the structural integrity and overall safety of the firearm.[2]
From a forensic perspective, illegally modified firearms present unique challenges during their examination. Alterations in the chamber dimensions, cartridge chambering, pressure distribution, and ballistic performance can produce characteristic marks and firing signatures that differ from those of standard firearms (O'Keeffe et al., 2015). Consequently, conventional firearm identification methods may require careful interpretation when examining modified weaponry. Therefore, detailed documentation of these alterations is essential for accurate forensic reconstruction, determination of firearm functionality, identification of the ammunition used, and presentation of scientific evidence in courts of law (*Firearms and Toolmarks | NIST*, 2024).[3]
The present study documents a significant case involving the mechanical modification of a factory-manufactured .303 British bolt-action rifle to chamber and successfully discharge a 7.62 × 51 mm cartridge. The modification was achieved by introducing a metallic layer at the shoulder-to-neck junction of the chamber, thereby reducing the chamber dimensions to accommodate a smaller cartridge case geometry. Test firing confirmed the successful functioning of the altered firearm with 7.62 × 51 mm ammunition, demonstrating that a relatively simple mechanical alteration can substantially change the weapon's operational capability.[4]
The research further presents a comparative forensic examination of the modified firearm with a standard .303 British bolt-action rifle and a standard 7.62 × 51 mm self-loading rifle. Particular emphasis is placed on differences in chamber dimensions, ammunition compatibility, muzzle velocity, and other forensic characteristics that aid in distinguishing modified firearms from their standard counterparts. By documenting these distinctive features, the study contributes valuable reference data for forensic firearm examiners investigating cases involving illegally altered weapons (O'Keeffe et al., 2015).[5]
The results of the current study reveal the relevance of identifying illegal modifications of chambers, as well as their effect on the functioning of firearms and ballistics. This study highlights the necessity of conducting precise tests to identify hidden mechanical modifications and reveals some important aspects that could be useful for forensic laboratories and investigative agencies in examining illegal modifications of firearms from a scientific perspective. This study is important from the perspective of forensic literature because it reveals the transformation of legal firearms into illegal weapons through chamber modifications (O'Keeffe et al., 2015).[6]

2. Methodology:

The present study was conducted to determine the type of structural modification made on a factory-produced bolt-action .303 British rifle. Basically, the work allowed it to chamber and then discharge a

7.62 × 51 mm cartridge, or so it was intended. The main objective of the study was to determine the type of mechanical change that occurred, record the chamber dimensions after the alteration, check whether the changed firearm functioned properly, and then compare the ballistics it produced with those from standard firearms.[7]

2.1. Examination of Submitted Firearm

The submitted firearm underwent thorough examination visually and mechanically using forensic firearm examination procedures. Examinations were conducted on the exterior parts of the firearm, which included the barrel, receiver, bolt assembly, trigger assembly, magazine assembly, and chamber, for any modifications or alterations made to the firearm. Close scrutiny was made of the chamber part of the firearm, where it appeared that alterations had been made to the firearm to fire other types of ammunition other than those designed for this type of firearm.[8]

The submitted firearm was a factory-made bolt-action rifle of .303 British caliber and was designed to be fired with .303 British cartridges. However, through close observation, it was discovered that there were modifications in the chamber portion of the firearm. The modification in the chamber was called a mechanical alteration.[9]

2.2. Chamber Modification:

A detailed examination of the chamber revealed that a metallic layer had been introduced at the shoulder-to-neck junction of the chamber. This additional metallic lining effectively reduced the internal diameter of the chamber at the shoulder region, thereby modifying the chamber dimensions to accommodate a 7.62 × 51 mm cartridge instead of the original .303 British cartridge.[10]

The shoulder-to-neck junction is a critical region of the chamber that provides positional support to bottleneck cartridges during chambering and firing (Massaro, 2019). Any alteration in this region directly affects cartridge seating, head positioning, chamber pressure distribution, and overall firearm function; by reducing the diameter at this junction, the modified chamber was able to provide sufficient support for the comparatively smaller 7.62 × 51 mm cartridge case (O’Keeffe et al., 2015).[11]

The modification occurred mostly in the shoulder/neck region, while the rest of the barrel had the same dimensions as that of the .303 British rifle. This type of change is an example of how one makes an adaptation of a gun designed for some type of ammunition into a gun able to fire another kind of ammunition (O’Keeffe et al., 2015).[12]

2.3. Measurement of the Chamber Dimensions:

To verify the extent of the modification, dimensional measurements were performed using a precision Vernier caliper with a least count of "0.02 mm". Measurements focused on the shoulder-to-neck junction diameter of the cartridges, which directly corresponded to the modified portion of the chamber.[13]

The shoulder-to-neck junction diameter of a standard .303 British cartridge and a standard 7.62 × 51 mm cartridge were measured separately under identical conditions. Multiple measurements were taken to minimize random observational error, and the average values were recorded.[14]

A comparison of the measurements demonstrated that the shoulder-to-neck junction diameter of the 7.62 × 51 mm cartridge was smaller than that of the .303 British cartridge. This dimensional difference explains the necessity of reducing the chamber diameter to permit proper seating of the 7.62 × 51 mm cartridge. The observed reduction in the chamber diameter corresponded with the location of the metallic lining identified during visual examination, thereby confirming that the chamber had been intentionally modified to chamber 7.62 × 51 mm ammunition.[15]

Figure 1: It shows the types of ammunition used in this examination - .303” (7.7 x 56 mm) caliber cartridge, and 7.62 x 51 mm caliber cartridge (up to down)

The dimensional comparison provided direct forensic evidence supporting the conclusion that the submitted firearm underwent mechanical alteration.[16]

2.4. Test Firing Procedure:

Following the completion of the physical examination, the altered firearm was subjected to controlled test firing to determine its operational capability and ballistic performance. Prior to firing, the firearm was inspected to ensure that the barrel was free of obstructions and that the bolt mechanism operated safely under controlled laboratory conditions.[17]

A standard 7.62 × 51 mm cartridge was chambered into the modified firearm, and test firing was conducted using appropriate forensic safety precautions. Successful discharge confirmed that the altered chamber was capable of accommodating, firing, and extracting the modified ammunition despite the firearm originally being manufactured for the .303 British cartridge.[18]

For comparative analysis, controlled test firing was conducted using the following:

- A standard factory-manufactured .303 British bolt-action rifle.
- A standard 7.62 × 51 mm self-loading rifle (SLR).

All firearms were fired under comparable environmental conditions using standard ammunition that was appropriate for each firearm.[19]

2.5. Measurement of Muzzle Velocity:

The ballistic performance of the firearms was evaluated by measuring the muzzle velocity using the BMS software integrated with the laboratory velocity measurement equipment. The system recorded the projectile velocity immediately after the bullet exited the muzzle.[20]

Multiple test shots were fired from each firearm, and the corresponding muzzle velocities were noted. The average muzzle velocity was calculated for the modified firearm (Figure 2), standard .303 British rifle (Figure 3), and standard SLR (Figure 4).[21]

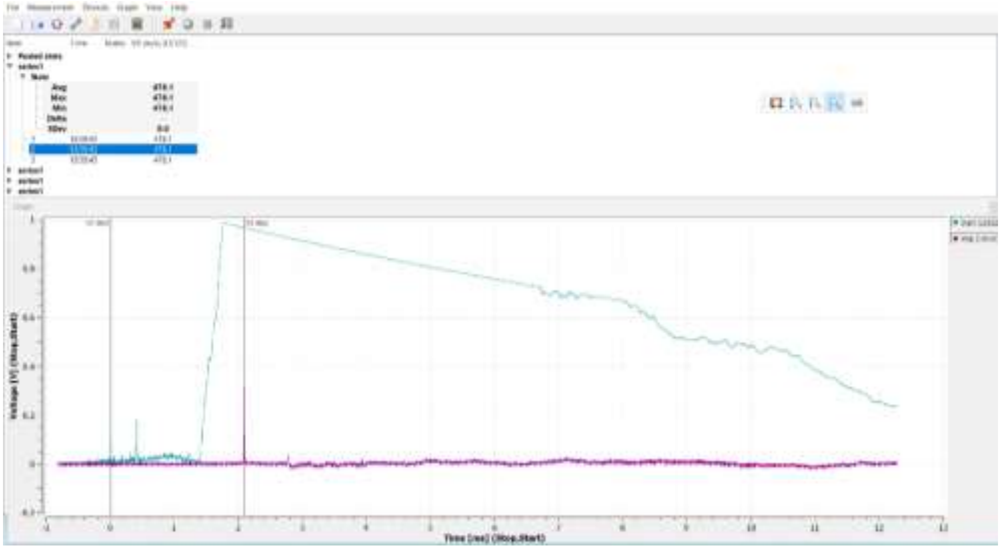


Figure 2: Muzzle velocity graph of the modified .303" British rifle, which can only fire ammunition of caliber 7.62 x 51 mm, using BMS software.

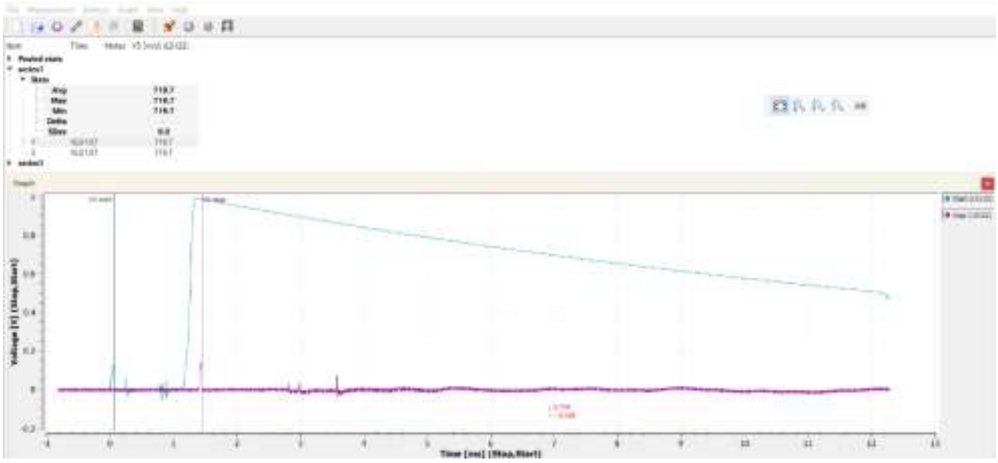


Figure 3: Muzzle velocity graph of a standard .303" British rifle, which only fires standard ammunition of caliber .303" (7.7 x 56 mm), using BMS software.

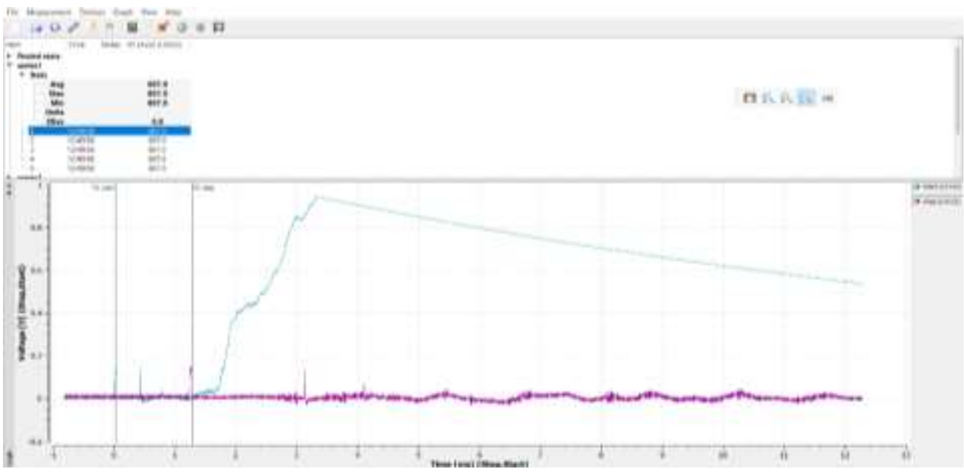


Figure 4: Muzzle velocity graph of a standard self-loading rifle (SLR), which can only fire standard ammunition of caliber 7.62 x 51 mm, using BMS software.

The measured data demonstrated that the muzzle velocity produced by the modified firearm was considerably lower than that obtained from both standard firearms. The reduction in muzzle velocity may be attributed to the altered chamber geometry, inefficient obturation, gas leakage, improper pressure development, and inability of the modified firearm to maintain the internal ballistic conditions for which the 7.62 × 51 mm cartridge was originally designed (Degirmenci, 2015).[22]

2.6. Examination of Fired Cartridge Cases:

Following test firing, all fired cartridge cases were recovered and subjected to forensic examinations. The cartridge cases were visually inspected for characteristic firing marks, chamber impressions, extractor marks, ejector marks (where applicable), and evidence of abnormal deformations.[23]

Particular attention was given to cartridge cases fired from modified firearms. Examination revealed noticeable bulging of the cartridge-case walls, shown in Figure 6. The deformation was consistent with the abnormal expansion caused by high-pressure combustion gases acting on portions of the cartridge case that were inadequately supported by the altered chamber. Such bulging indicates improper chamber conformity and reflects the inability of the improvised chamber modification to provide a uniform support during firing.[24]

Figure 6: It shows bulging in the lower portion of the empty cartridge case, which was fired using the modified .303" British rifle, indicating improper chamber conformity.

The fired cartridge cases from the standard .303 British rifle and standard SLR did not exhibit comparable deformation, indicating that their factory-manufactured chambers maintained proper cartridge support and pressure containment during firing.[25]

2.7. Comparative Analysis:

The observations obtained during firearm examination, dimensional measurements, ballistic testing, and fired cartridge case analysis were comparatively evaluated to distinguish the characteristics of the modified firearm from those of the standard .303 British rifle and standard SLR.[26]

The comparative examination focused on the following:

- Chamber geometry and structural modifications.
- Cartridge compatibility.
- Shoulder-to-neck junction dimensions.
- Operational functionality.
- Muzzle velocity.
- Fired cartridge case characteristics.
- Evidence of abnormal pressure effects.

The methodology adopted in this study enabled systematic documentation of mechanical alterations and their influence on firearm functionality and ballistic behavior, providing forensic evidence for identifying and characterizing illegally modified firearms (O'Keeffe et al., 2015).[27]

3. Result:

The result from the examination of the illegally modified bolt-action .303" British rifle is that it is designed in such a way that it propels 7.62 x 51 mm caliber ammunition. The differences in the dimensions of the chamber of standard firearms (a bolt-action .303" British rifle and an SLR rifle) and the altered firearm are given in Table 3.1.

Dimensions of Chamber of Firearm	Standard Bolt-Action .303" British Rifle	Standard Self-Loading Rifle (SLR)	Modified Bolt-Action .303" British Rifle
Neck Diameter	0.345" (8.80mm)	0.345" (8.80mm)	~ 0.345" (8.80mm)
Shoulder-to-Neck Junction Diameter	0.401" (10.19mm)	0.345" (8.80mm)	~ 0.345" (8.80mm)
Shoulder Diameter	0.403" (10.24mm)	0.454" (11.53mm)	~ 0.403" (10.24mm)
Base Diameter	0.460" (11.68mm)	0.470" (11.94mm)	~ 0.460" (11.68mm)

Table 3.1: Measurement of dimensions of chamber of the standard bolt-action .303" British rifle, the standard self-loading rifle (SLR), and the modified bolt-action .303" British rifle.

The above mentioned table indicates that by adding an extra metal layer at the shoulder-to-neck junction of the chamber of a factory-manufactured bolt-action .303" British rifle and keeping the other dimensions similar to the standard firearm, it can successfully chamber a 7.62 x 51 mm caliber cartridge.[28]

The types of ammunition used for the examination were a .303" (7.7 x 56 mm) caliber cartridge, which is used in a traditional .303" British rifle, and a 7.62 x 51 mm caliber cartridge, which is used in a standard SLR rifle and in the obtained modified firearm. Their measurements were taken using a vernier caliper with a least count of 0.02 mm. The differences in the dimensions of these ammunitions are represented in Table 3.2

Dimensions of Ammunition	.303" (7.7 x 56mm) Caliber Cartridge	7.62 x 51mm Caliber Cartridge
Bullet Diameter	7.76mm	7.68mm
Neck Diameter	8.56mm	8.64mm
Shoulder-to-Neck Junction Diameter	8.68mm	8.66mm

Shoulder Diameter	10.10mm	11.22mm
Base Diameter	11.64mm	11.92mm
Rim Diameter	13.42mm	11.94mm
Cartridge Case Length	56.06mm	51.02mm
Total Length of the Cartridge	76.88mm	70.50mm

Table 3.2: Measurement of dimensions of .303” (7.7 x 56 mm) caliber cartridge, and 7.62 x 51 mm caliber cartridge.

Based on the obtained measurements of both the ammunition, it can be observed that the .303” caliber cartridge is longer in length and has a larger shoulder-to-neck junction diameter than the 7.62 x 51 mm caliber cartridge. However, the firearm’s chamber only chambers the 7.62 x 51 mm caliber cartridge. This indicates that the chamber length was also reduced for the same purpose.[29]
For the test firing of the altered firearm, a 7.62 x 51 mm caliber cartridge was used instead of a standard .303” (7.7 x 56 mm) caliber cartridge. This is because the chamber of the firearm was able to load a 7.62 x 51 mm cartridge properly instead of the standard ammunition due to a modification that occurred inside the chamber. The muzzle velocity of this improvised firearm was measured along with that of a factory-made 0.303” caliber British rifle and a standard SLR rifle, using the BMS software. The differences in their muzzle velocity are as given in Table 3.3.

Type of Firearm	Muzzle Velocity
Standard Bolt-Action .303” British Rifle	719.7 m/s
Standard Self-Loading Rifle (SLR)	807.0 m/s
Modified Bolt-Action .303” British Rifle	478.1 m/s

Table 3.3: Muzzle velocities of the standard bolt-action .303” British rifle, the standard self-loading rifle (SLR), and the modified bolt-action .303” British rifle.

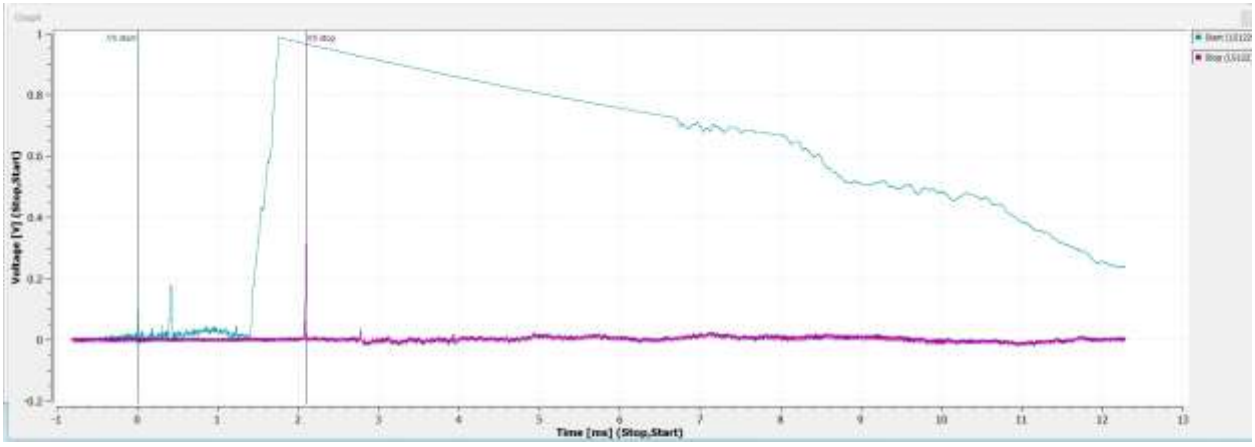
When a 7.62 x 51 mm caliber cartridge was fired from the modified firearm, it caused a bulge at the lower portion of the fired cartridge. This bulging occurs when the heat and gases formed by the ignition of the propellant are trapped in the case due to the absence of free space for the gases to travel out of the firearm. This causes pressure to build up inside the case, making it bulge.[30]

4. Discussion:

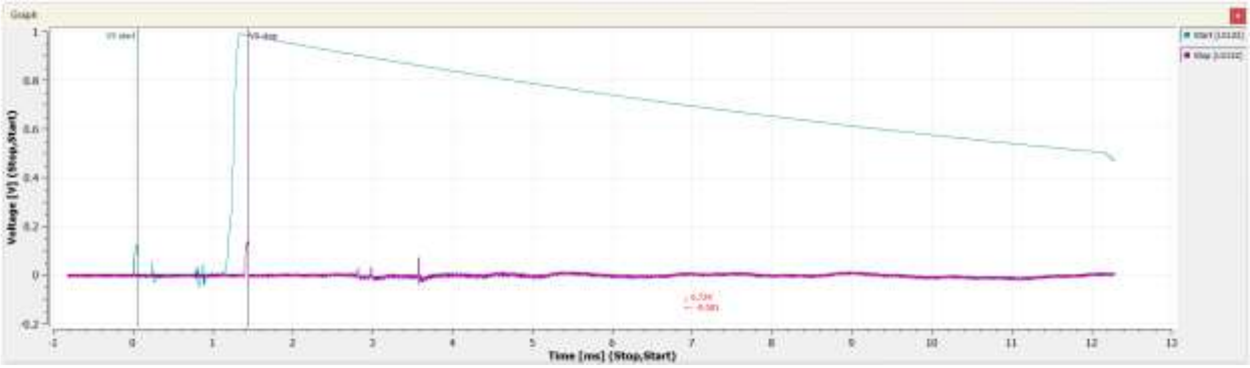
Dimensional analysis of the firearm chamber confirmed that the most significant alteration occurred at the shoulder-to-neck junction. In a standard .303 British rifle, this region has a larger diameter and longer length than that of a standard 7.62 × 51 mm chamber. By reducing this dimension to approximately match that of the 7.62 × 51 mm cartridge, the modified firearm successfully chambered a smaller cartridge while retaining most of the original chamber dimensions. Such selective modifications indicate that the individual performing the alteration understood the critical role of the shoulder in positioning the cartridge within the chamber. This observation is consistent with the principles of firearm chamber design, in which the shoulder serves as a major headspacing surface for bottleneck cartridges (Sinha, 2014).[31]

The comparison of the ammunition dimensions further supports the observed modification. Although both cartridges have comparable neck diameters, they differ considerably in shoulder diameter, rim diameter, case length, and overall cartridge length. The .303 British cartridge is a rimmed cartridge with a longer case, whereas the 7.62 × 51 mm cartridge is rimless and comparatively shorter. These dimensional differences generally prevent interchangeability under normal conditions. Therefore, the successful chambering of the 7.62 × 51 mm cartridge demonstrates that the chamber geometry was intentionally altered rather than the firearm merely accepting an undersized cartridge due to excessive wear.[32]

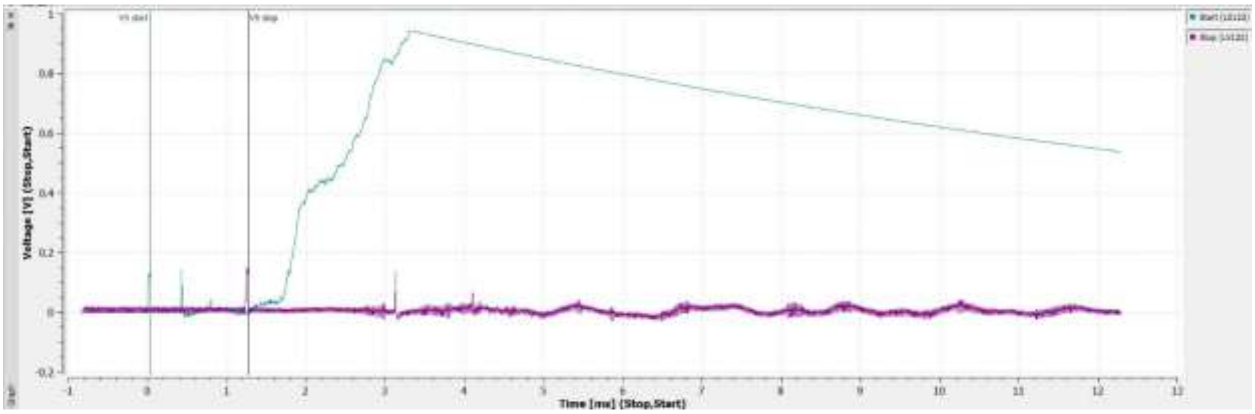
The experimental test firing established that the altered firearm was capable of firing the 7.62 × 51 mm cartridge; however, its ballistic performance differed substantially from that of standard firearms. The modified firearm produced a muzzle velocity of 478.1 m/s, which is significantly lower than the 719.7 m/s recorded for the standard .303 British rifle and the 807.0 m/s obtained from the standard SLR. This reduction in muzzle velocity indicates inefficient conversion of propellant energy into projectile motion. Several factors may contribute to this phenomenon, including poor chamber sealing, gas leakage around the cartridge case, increased free-bore distance, improper headspace, and non-standard chamber dimensions resulting from the modification. Together, these factors reduce the pressure available to accelerate the projectile through the barrel, thereby decreasing the muzzle velocity.[33]



(a)



(b)



(c)

Figure 7(a),(b),(c): They show comparative graphs of muzzle velocities of the modified .303" British Rifle, the standard .303" British Rifle, and the standard Self-Loading Rifle (SLR), respectively.

The significant decrease in projectile speed has important forensic and ballistic implications. Muzzle velocity is a direct factor influencing projectile energy, effective range, penetration capability, trajectory, and terminal performance (Dickson, 2026). Therefore, the modified gun is likely to have less efficient ballistics, be less accurate, and its terminal effects remain even more unpredictable when compared to standard factory-made guns. These features hinder crime scene reconstruction, estimation of firing distance, and interpretation of wound ballistics during forensic investigations.[34]

Another important observation during the test firing was the bulging of the fired cartridge case. Cartridge case expansion is a well-recognized indicator of abnormal chamber pressure or inadequate chamber support (Team, 2026). In the present study, bulging occurred primarily in the lower portion of the cartridge case, suggesting that the modified chamber failed to provide adequate support during the firing. When the propellant ignites, rapidly expanding gases generate high pressure within the cartridge case. In a properly manufactured firearm, these gases are efficiently directed behind the projectile, while the chamber uniformly supports the cartridge case (Krcma, 1996). However, in the altered firearm, the imperfect chamber geometry and inadequate sealing likely caused localized pressure concentration, resulting in plastic deformation of the cartridge case. Such deformation serves as an important forensic indicator of chamber alteration or excessive headspace (Krcma, 1996).[35]

The observed cartridge bulging also indicates potential safety hazards associated with illegally modified firearms. Abnormal pressure distribution may lead not only to deformation of cartridge cases but also to case rupture, gas escape toward the shooter, damage to the firearm, or catastrophic structural failure during repeated firings (Cai et al., 2020). These risks underscore the importance of precise control of chamber dimensions and headspace tolerances during firearm manufacturing and why unauthorized modifications substantially increase the likelihood of mechanical failure (*Headspace (Firearms) Explained*, n.d.).[36]

From a forensic science perspective, the findings emphasize the importance of systematic dimensional examination during firearm identification. The measurement of critical chamber dimensions using precision instruments, such as a vernier caliper, enabled the identification of the modified region and provided objective evidence supporting the conclusion that the firearm had been mechanically altered (*Firearms and Toolmarks | NIST*, 2024). Such dimensional analysis, when combined with functional testing, examination of fired cartridge cases, and ballistic performance evaluation, provides a comprehensive approach for identifying improvised or illegally modified firearms.[37]

Furthermore, the considerable difference in muzzle velocity between modified and standard firearms may serve as an additional diagnostic parameter during forensic examinations. Ballistic velocity measurements can reveal deviations in firearm performance that may not be immediately apparent through visual inspection. When interpreted together with chamber dimensions and cartridge case characteristics, these measurements strengthen forensic conclusions regarding the operational conditions and legality of altered firearms (O’Keeffe et al., 2015).[38]

Overall, the present investigation demonstrates that relatively localized modifications to the chamber of a .303 British rifle are sufficient to enable firing of 7.62 × 51 mm ammunition, albeit with markedly compromised ballistic performance and increased mechanical risk. The reduced muzzle velocity, altered chamber dimensions, and characteristic cartridge case bulging collectively provide valuable forensic evidence of firearm modification. These findings contribute to the understanding of illicit firearm conversions and highlight the importance of integrating dimensional measurements, test firing, and ballistic analysis in forensic firearm examinations (O’Keeffe et al., 2015). Future investigations incorporating pressure measurements, metallurgical characterization of modified chamber surfaces, and high-speed imaging of the firing process would further enhance the understanding of the mechanical behavior and forensic significance of such illegally modified firearms.[39]

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