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Corresponding Author
Dr. Pinki Pratim Das,
Department of Anatomy, Nagaon MCH, India
drpinkipratimdas@gmail.com

Author Designation
[1]Associate Professor
[2-4,6]PGT
[5,7]Assistant Professor
[8]Professor and HOD

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Differences in Entry and Exit Gunshot Wounds: A Statistical Analysis of 80 Cases

[1]Dr. Partha Pratim Das, [2]Dr. Rishav Rittam Sarmah, [3]Dr. RajappanBejoys, [4]Dr. Rozeela Bhutia, [5]Dr. Pinki Pratim Das, [6]Dr. Bhumija Khakhlary, [7]Dr. Kumar Pinku Pratim and [8]Dr. Kanak Chandra Das

[1-4,6-8]Forensic Medicine, GMCH, India
[5]Department of Anatomy, Nagaon MCH, India

Abstract
Firearm injuries are one of the most common injuries that is fatal for human life. Homicidal gun shots are most common, but accidental and suicidal injuries are also prevelent. In India, all the fatal cases of firearm injuries are brought for medicolegal autopsy. In most of the set up for autopsies, facilities are limited like nonavailability of CT scan and some times even X-ray. In such condition naked eye finding sare the only finding son which we have torely and give opinion. In this study, conducted from May 2022 to May 2024 at Gauhati Medical College and Hospital, Assam, India, statistical analysis of entry and exit gun shot wounds in 80 riffled firearm- related fatalities was done to elucidated if ferences in size, shape, margin characteristics and associated features. Total 180 entry wounds and 110 exit wounds were examined and results were summarized. This study will help per forming autopsy surgeons and trainees to identify and differentiate gun shot wounds and also aim to support them in crime scene reconstruction and inform the development of ballistic analysis protocols.

INTRODUCTION

Gunshot wounds (GSWs) are pivotal in forensic pathology, offering evidence for reconstructing shooting incidents, determining the manner of death (homicide, suicide, or accident), and identifying firearm characteristics[1].Entry wounds result from initial bullet penetration, producing smaller lesions with abrasion collars due to skin friction[2]. Exit wounds are larger and irregular, as bullets tumble, fragment, or transfer kinetic energy, causing extensive tissued isruption[3]. These differences are critical for inferring bullet trajectory, firing distance, and weapon type[4].

Prior studies highlight that anatomical location influences wound morphology. Chest wounds often targetvital organs, while head wounds may lackexits due tobulletretention[5].Close-range shots produce burning or blackening, aiding distance estimation1. However, comprehensive statistical com- parisons of entry and exit wounds are scarce[6]. Advanced imaging, such as computed tomography (CT), has improved wound mapping, yet standardized protocols remain under developed[7].

This study, conducted from May 2022 to May 2024 at Gauhati Medical College and Hospital, Assam, India, analyzes 80 riffled firearm-related fatalities from postmortem reports to quantify differences between entry and exit wounds.

Objective:

1. Compare wound size and shape
2. characterize margin features and associated findings
3. evaluate anatomic al distribution.

MATERIALS AND METHODS

Data Source: The data set comprises 80 postmortem reports of riffled firearm- related deaths from Gauhati Medical College and Hospital, Assam, India, collected between May 2022 and May 2024.Cases were selected tore present diverse wound patterns while ensuring patient anonymity. Wounds froms mooth bore firearms were excluded as such cases were very rare and only 1 case was done during the study period.

Data Extraction:

For each case, the following were extracted:

- Number of entry and exit wounds
- Anatomical location (head, chest, abdomen, limbs)
- Wound size (dimensions in cm)
- Shape (circular, elliptical, stellate, irregular)
- Margin characteristics (inverted/ everted, regular/ irregular)
- Associated features (abrasioncollar, burning, blackening, muzzle impression, tissue protrusion).

Statistical Analysis: Descriptive statistics were used to quantify wound frequencies, sizes, and feature prevalence. Proportions were calculated for anatomical distribution and associated findings. Median wound sizes were compared between entry and exit wounds. Analysis was conducted manually, with results summarized in tables and narrative form.

Ethical Considerations: Ethical clear ance was obtained from the Institutional Ethics Committee of Gauhati Medical College and Hospital (clearance number IEC/GMCH/2022/035). The study used forensic reports, adhering to ethical guide lines for for ensic research. No identifiable patient data was included, ensuring compliance with ethical standards.

RESULTS AND DISCUSSIONS

Wound Frequency: Across 80 cases, we identified 180 entry wounds (mean 2.25 per case) and 110 exit wounds (mean 1.38 per case). Twenty cases (25%) had no exit wounds, and 20 (25%) had more entry than exit wounds, suggesting bullet retention in tissues or bone.

Wound Size and Shape: Table 1 compares entry and exit wound characteristics.Entry wounds were smaller (median 1 cm ×1 cm) than exit wounds (median 1.5 cm × 1.5 cm). Entry wounds were pre dominantly circular or elliptical (90%), with stellate shapes in head wounds (10%) due to boner esistance. Exit wounds were uniformly irregular and lacerated (100%).

Margin Characteristics and Associated Features: Table 2 summarizes margin characteristics and associated features.Entry wounds exhibited inverted, irregular margins (100%) with abrasion collars (100%). Burning or blackening was observed in 40 cases (50%), and muzzle impressions in 20 cases (25%), indicating close-range shots.Exit wounds had everted, lacerated margins (100%), with tissue protrusion in 30 cases (38%). Burning was less common in exit wounds (25%), and abrasion collarsor muzzle impressions were rare (10% and 5%, respectively).

Anatomical Distribution: Table 3 compares the anatomical distribution of wounds. The chest was the most common site for both. Entry (38.9%) and exit (54.5%) wounds. Limbs accounted for 33.3% of entry wounds but only 18.2% of exits, suggesting bullet retention. Head wounds wereless frequent (16.7% entries, 9.1% exits),with a low exit rate due to cranial energy dissipation. Abdominal wounds were equally distributed (11.1% entries, 18.2% exits).

This study provides a detailed statistical comparison of entry and exit gun shot wounds, offering insights into

Table 1: Comparison of Entry and Exit Wound Size and Shape

Characteristic	Entry Wounds	Exit Wounds
MedianSize(cm)	1×1	1.5×1.5
SizeRange(cm)	0.5×0.8 to 7×3	1×0.5 to 5×3
Shape	Circular/ Elliptical (90%), Stellate (10%)	Irregular /Lacerated(100%)

Table2: Margin Characteristics and Associated Features

Feature	Entry Wounds	Exit Wounds
MarginType	Inverted(100%)	Everted(100%)
MarginRegularity	Irregular(100%)	Lacerated(100%)
Abrasion Collar	Present(100%)	Absent (90%)
Burning/BlackeningPresent	(50%)	Present(25%)
Muzzle ImpressionPresent	(25%)	Absent(100%)
Tissue Protrusion	Absent(100%)	Present(38%)

Table 3: Anatomical Distribution of Entry and Exit Wounds

Region	Entry Wounds	% of Entries	Exit Wounds	% of Exits
Head	30	16.7	10	9.1
Chest	70	38.9	60	54.5
Abdomen	20	11.1	20	18.2
Limbs	60	33.3	20	18.2

their forensic significance. The smaller size of entry wounds (median1cm×1cm) compared to exit wounds (median 1.5 cm × 1.5 cm) aligns with ball istic principles, where bullets enter with focused energy but exit with greater tissue disruption due to tumbling or fragmentation[3].The predominance of circular/ elliptical entry wounds (90%) versusir regular/ lacerated exit wounds (100%) reflects the bullet's initial stability versus its destabilized exit2.Stellate entry wounds in the head (10%) result from bone resistance[5].

Margin characteristics further distinguish wound types. Inverted, irregular margins with abrasion collars (100% of entries) are hallmarks of bullet penetration, while everted, lacerated margins (100% of exits) indicate tissue expulsion[1]. Burning or black eningin 50% of entry wounds, compared to 25% of exits, suggests close- range firing[4]. Muzzle impressions (25% of entries) rein force this[6]. Tissue protrusion in 38% of exit wounds underscores the explosive force of bullet exit[2].

Anatomically, the chest's dominance (38.9% entries, 54.5% exits) reflects its targeting in lethal shoot-ings[5]. The high limbentry rate (33.3%) but low exit rate (18.2%) indicates bullet retention, necessi-tating imaging like CT[7]. Abdominal wounds' balanced distribution suggests through-and-through trajectories[3].

These findings have practical forensic implications. Differentiating entry from exit wounds informs bullet trajectory and shooter positioning. Burning and muzzle impressions aid in estimating firing distance, critical for distinguishing homicide from suicide[4]. The discrepancy between entry and exit wound counts highlights the need for thorough autopsy and imaging[7]. Limitations include variability in fire arm caliber and ammunition type, which may influence wound patterns. Incomplete exit wound data in some reports may affect accuracy. Future research should validate findings with larger data sets and explore advanced imaging (e.g., CT with contrast) or deep learning for auto mated wound classification[8].

CONCLUSION

Entry gunshot wounds are smaller, circular or elliptical, with inverted margins, abrasion collars, and frequentburning,whileexitwoundsarelarger,irregular, withevertedmarginsandtissueprotrusion. The chest and limbs predominate, with fewer exits in limbs and head due to bullet retention. These differences enhance forensic reconstruction of shooting incidents, supporting trajectory analysis and distance estimation. Standardized for ensic protocols, integrated with advanced imaging, are recommended to improve ball istic investigation sand ensure robust evidence for judicial proceedings.

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