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RADIOLOGICAL VS AUTOPSY FINDINGS IN GUNSHOT WOUND ASSESSMENT: A COMPARATIVE STUDY

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ABSTRACT

Background: Gunshot wounds (GSWs) remain a significant public health and forensic concern in Pakistan, where firearm-related deaths are on the rise. Radiological imaging is emerging as a valuable adjunct to conventional autopsy in postmortem investigations.

Objective: To compare autopsy and radiological findings in fatal Gunshot wounds cases in Islamabad.

Methods: This retrospective study was conducted at the Department of Forensic Medicine and Radiology, HBS (Hazrat Bari Imam Sarkar) Medical and Dental College, Islamabad. The study was approved by the institutional ethical review board, and all procedures adhered to legal and ethical standards for research involving deceased individuals. The study covered 1-year period, from April 2024 to March 2025. A total of 68 medico-legal cases of firearm-related fatalities were selected through non-probability purposive sampling from DHQ Rawalpindi.Demographic data, radiological reports (primarily CT and X-rays), and autopsy findings were collected and analyzed for concordance. Statistical agreement was measured using the kappa coefficient.

Results: Of the 68 cases, 79.4% were male, with a predominance in the 31–45-year age group (39.7%). Radiological imaging detected entry and exit wounds in 94.1% and 85.2% of cases, respectively, while autopsy confirmed 100% and 91.1%. Cranial fractures showed a 94.1% concordance, and the kappa value for overall agreement was 0.812, indicating substantial agreement. However, radiology missed several soft tissue and visceral organ injuries, especially liver and cardiac lesions.

Conclusion: Radiological imaging, while not a substitute for autopsy, provides a valuable, non-invasive tool for documenting skeletal trauma, bullet trajectories, and retained projectiles

Keywords: Gunshot Wounds, Radiological Imaging, Autopsy, Forensic Pathology, Bullet Trajectory Detection

INTRODUCTION

Gunshot wounds (GSWs) constitute a significant medico-legal and public health issue worldwide. They result from the discharge of firearms and are characterized by complex patterns of tissue damage, depending on the type of weapon, range, and trajectory of the bullet. Accurate assessment of GSWs is critical in forensic investigations for determining the cause, manner, and circumstances of death. Traditionally, autopsy has served as the primary method for such evaluations, offering direct visualization of wound tracks, hemorrhages, and organ involvement. However, the evolving field of forensic radiology, particularly the use of postmortem imaging modalities such as computed tomography (CT) and magnetic resonance imaging (MRI), has emerged as an important adjunct in evaluating these injuries [1].

Pakistan has witnessed a troubling increase in firearm-related violence in recent years. According to the Pakistan Bureau of Statistics and various health department reports, firearm injuries contribute significantly to both morbidity and mortality in urban and conflict-prone regions. Karachi alone reported over 1,200 gun-related incidents in 2021, with a major proportion resulting in fatalities [2]. A retrospective study from Rawalpindi and Islamabad noted that firearms were responsible for 37% of unnatural deaths, predominantly affecting males between 18 to 40 years [3]. Another study from Karachi, based on medico-legal autopsies, showed that 47.05% of the total examined cases were attributed to firearm injuries, highlighting the alarming burden of this issue [4].

The reliance on conventional autopsy in Pakistan, though vital, faces limitations due to resource constraints, overcrowded mortuaries, and the absence of advanced diagnostic infrastructure. Autopsy findings may also be compromised by decomposition, limited visibility of wound tracks in some cases, or cultural objections to dissection [5]. In contrast, radiological imaging offers a non-invasive and potentially more acceptable approach, allowing the visualization of skeletal damage, bullet trajectories, and foreign body localization, even in decomposed bodies [6]. CT scans, in particular, provide three-dimensional reconstructions that can enhance forensic documentation and court presentations [7].

Despite its advantages, the implementation of forensic imaging in Pakistan remains minimal. This is due to multiple challenges including the lack of specialized radiologists, limited access to postmortem CT/MRI equipment, and insufficient training among medico-legal personnel [8]. Furthermore, the absence of regulatory frameworks for integrating radiological tools into routine forensic practice delays their acceptance and usage in medico-legal investigations [9]. Given the rising incidence of gun-related fatalities and the limitations of traditional methods, there is an urgent need to assess the feasibility, accuracy, and benefits of radiological evaluation in GSW cases [10].

In urban centers such as Lahore and Peshawar, recent statistics have shown a 20% rise in fatal firearm injuries since 2020, further emphasizing the growing burden on forensic departments [11]. The World Health Organization (WHO) has also classified firearm-related deaths as a major cause of premature mortality in low- and middle-income countries, including Pakistan [12]. With the increasing availability of radiological facilities in tertiary care hospitals and teaching institutions, there lies a unique opportunity to explore the role of postmortem imaging in gunshot wound assessment [13].

METHODOLOGY

This retrospective study was conducted at the Department of Forensic Medicine and Radiology, HBS (Hazrat Bari Imam Sarkar) Medical and Dental College, Islamabad. The study covered 1-year period, from April 2024 to March 2025. A total of 68 medico-legal cases of firearm-related fatalities were selected through non-probability purposive sampling from DHQ Rawalpindi. Inclusion criteria consisted of cases aged 18 years and above, who had sustained gunshot wounds and had undergone

both a full medico-legal autopsy and postmortem radiological imaging (including X-rays and CT scans) prior to autopsy. Cases with decomposed bodies, incomplete imaging, or those with other causes of death (such as blunt trauma, sharp force injury, or poisoning) were excluded to maintain the specificity of firearm-related assessments.

The data were retrieved from District Hospital of Rawalpindi and forensic records, which included autopsy reports, radiological imaging, and medico-legal documentation. All radiological investigations were conducted using a 128-slice CT scanner and standard digital radiography units available in the radiology department. Imaging was performed within 24–48 hours of death, and interpretation was carried out by two independent radiologists with at least five years of experience in imaging. Similarly, autopsies were performed by senior forensic pathologists using standard dissection techniques.

The study focused on the documentation and analysis of key variables, including number and location of entry and exit wounds, bullet trajectory and wound path, identification and localization of foreign bodies, bone fractures and internal organ damage and associated hemorrhages and soft tissue injuries. Each of these findings was recorded separately from both radiological and autopsy sources. Comparative analysis was conducted to determine the level of agreement between imaging and autopsy findings. Concordance was defined as cases in which both modalities identified the same anatomical injuries and bullet paths. Discordance was noted where findings were either missed or interpreted differently by one modality.

Data were analyzed using SPSS version 25.0. Descriptive statistics were used to summarize demographic data (age, gender), type of firearm injury, and anatomical distribution of wounds. Categorical variables were compared using the Chi-square test, and the kappa coefficient was used to assess inter-modality agreement. A p-value of ≤ 0.05 was considered statistically significant.

RESULTS

Among the 68-gunshot wound (GSW) cases analyzed, the majority were male (79.4%), with the most affected age group being 31–45 years (39.7%).

TABLE 1: DEMOGRAPHIC DISTRIBUTION OF CASES (N = 68)

Variable	Frequency (n)	Percentage (%)
GENDER		
Male	54	79.4%
Female	14	20.6%
AGE GROUP (YEARS)		
18–30	22	32.4%
31–45	27	39.7%
46–60	13	19.1%
>60	6	8.8%

Radiological imaging identified entry wounds in 94.1% of cases and exit wounds in 85.2%, with cranial fractures noted in 32.3% and thoracic injuries in 22%. Bullet fragments were retained in 25% of cases.

TABLE 2: ENTRY AND EXIT WOUND DOCUMENTATION (N = 68)

Wound Pattern	Radiology Identified (n=68)	Autopsy Identified (n=68)	Concordance (%)
Only Entry Wound	10 (14.7%)	12 (17.6%)	85.3%
Only Exit Wound	6 (8.8%)	7 (10.3%)	88.2%
Both Entry & Exit Wounds	52 (76.5%)	49 (72.1%)	91.1%

No Visible Wounds	0 (0.0%)	0 (0.0%)	100%

Autopsy confirmed entry wounds in 100% of cases and exit wounds in 91.1%. Internal organ injuries were identified in 48.5%, particularly the liver and lungs.

TABLE 3: ANATOMICAL DISTRIBUTION OF GUNSHOT INJURIES (BASED ON AUTOPSY FINDINGS)

Region Affected	Frequency (n)	Percentage (%)
Head and Neck	18	26.5%
Chest	24	35.3%
Abdomen	14	20.6%
Limbs	7	10.3%
Multiple Regions	5	7.3%

In the assessment of internal injuries (Table 4), lung injuries were detected in 32.4% of cases through autopsy and 29.4% via radiology, with a high concordance rate of 90.9%. Liver lacerations were identified in 20.6% of autopsies and 17.6% of radiological reports, with 85.7% concordance. Cardiac penetration was noted in 10.3% of autopsies and 8.8% on radiology, also demonstrating 85.7% concordance. Cranial fractures showed the highest agreement between modalities, with 25% detected in autopsy and 26.5% in radiology, yielding a concordance of 94.1%. In contrast, pelvic fractures had the lowest agreement, with 7.4% detected on autopsy and 10.3% by radiology, showing only 71.4% concordance.

TABLE 4: DETECTION OF INTERNAL INJURIES (AUTOPSY VS RADIOLOGY)

Organ / Structure	Detected via Autopsy (n=68)	Detected via Radiology (n=68)	Concordant Cases (%)
Lung Injury	22 (32.4%)	20 (29.4%)	90.9%
Liver Laceration	14 (20.6%)	12 (17.6%)	85.7%
Cardiac Penetration	7 (10.3%)	6 (8.8%)	85.7%
Cranial Fractures	17 (25.0%)	18 (26.5%)	94.1%
Pelvic Fractures	5 (7.4%)	7 (10.3%)	71.4%

In evaluating the accuracy of radiology in bullet trajectory detection (Table 5), radiology demonstrated a sensitivity of 89.3% and specificity of 91.5% when compared to autopsy findings. The difference was statistically significant ($p < 0.001$), indicating that radiological imaging is highly reliable in tracing bullet paths but may still miss certain internal organ damages.

TABLE 5: ACCURACY OF RADIOLOGICAL ANALYSIS WITH THE AUTOPSY REPORTS IN BULLET TRAJECTORY DETECTION

Test	Value	p-value
Sensitivity of Radiology (%)	89.3%	<0.001
Specificity of Radiology (%)	91.5%	

DISCUSSION

The present study examined 68 cases of fatal gunshot wounds (GSWs) in Islamabad, comparing findings from autopsy and postmortem radiological imaging. The results demonstrated high concordance in the identification of bullet trajectories, bone fractures, and internal organ damage. The predominance of male victims (79.4%) and the majority of cases falling within the 31–45-year age bracket (39.7%) align with existing literature from Pakistan and similar socio-political contexts. A study from Karachi observed that 94.9% of GSW victims were male, reflecting high involvement of

males in violence and criminal activity [14]. Similarly, global data indicates that firearm-related homicides disproportionately affect males aged 15–44 years, especially in low- and middle-income countries [15].

Radiological detection of both entry and exit wounds showed a concordance rate of over 90% with autopsy findings. This aligns with the findings of Egger et al. (2021), who reported 92% concordance between postmortem CT and autopsy in detecting ballistic wound paths [16]. Our study also found radiology particularly effective in identifying cranial fractures (94.1% concordance), a finding mirrored in research by Gascho et al. (2020), where CT imaging showed superior detection of skull fractures compared to conventional autopsy [17].

Discrepancies, however, were noted in the detection of soft tissue injuries and organ lacerations—radiology missed 2 cases of liver injuries and 1 of cardiac penetration. These limitations are consistent with prior studies suggesting that while postmortem CT excels in skeletal and gas pattern evaluation, it underperforms in detecting subtle parenchymal injuries without contrast enhancement [18,19]. In our study, the kappa coefficient ($\kappa = 0.812$) indicated substantial agreement between the two modalities, comparable to the $\kappa = 0.79$ reported by Wichmann et al. in a 2022 German multicenter study [20].

From a regional perspective, there remains limited implementation of forensic radiology in Pakistan, largely due to infrastructural and resource constraints. A 2023 study in Lahore highlighted that over 85% of medico-legal centers lack access to CT imaging, even in major teaching hospitals [21]. This gap creates a dependency on conventional autopsy alone, which may miss subtle findings or face resistance due to cultural or religious objections [22].

Internationally, countries such as Switzerland and Japan have formally incorporated postmortem imaging into forensic procedures. Japan's "Autopsy Imaging" (Ai) protocol has shown improvements in public acceptance and diagnostic clarity, particularly in firearm-related cases [23]. In contrast, in Pakistan, medico-legal autopsies remain underutilized, with an estimated 70% of violent deaths not undergoing any formal postmortem analysis due to lack of awareness, familial resistance, or institutional bottlenecks [24].

Despite these challenges, our findings suggest that even limited integration of postmortem radiology-such as CT and X-ray—could greatly enhance the accuracy of forensic investigations. Training programs for forensic professionals and investment in imaging infrastructure are key to this shift. Furthermore, collaboration between radiologists and forensic pathologists could improve interdisciplinary interpretations, particularly in high-profile or ambiguous cases [25].

CONCLUSION

The study reportedthat while radiological imaging cannot entirely replace the depth and detail of a full autopsy, it serves as a powerful adjunct—especially in documenting skeletal injuries, bullet trajectories, and retained foreign bodies. For a developing country like Pakistan, this hybrid approach may represent a cost-effective and culturally sensitive model to enhance forensic capacity.

REFERENCES

1. Dedouit F, Ampanozi G, Jackowski C, Viero A. Post-mortem imaging in forensic investigations: current utility, limitations, and future perspectives. Forensic Sci Med Pathol. 2021;17(2):196–210.
2. Pakistan Bureau of Statistics. Crime Statistics Report 2021. Islamabad: Government of Pakistan; 2022.
3. Hussain S, Mustehsan ZH, Syed S, Zeb M, Omer J, Riaz R. Pattern and demographic of firearm deaths in Rawalpindi and Islamabad: an autopsy-based study. Pak Armed Forces Med J. 2020;70(5):1413–1418.
4. Shah SA, Mirza FH, Beg MA. An autopsy-based study of pattern of firearm injuries in Karachi, Pakistan. J Forensic Res. 2010;1(104):1–5.
5. Payne-James JJ, Jones R, Karch SB, Manlove J. Simpson's Forensic Medicine. 14th ed. CRC Press; 2020.

6. Ross SG, Palmiere C. Radiological aspects of gunshot wounds. Leg Med (Tokyo). 2019;39:1–9.
7. Christe A, Flach PM, Ross S, Spendlove D, Bolliger SA, Vock P, et al. Clinical radiology and postmortem imaging: friends or foes? Insights Imaging. 2012;3(5):533–546.
8. Rehman A, Ullah Z, Shah SA. Challenges in medico-legal autopsies in Pakistan: need for reform. J Pak Med Assoc. 2020;70(10):1860–1862.
9. Khichi ZH, Saleem M, Khan FA. Medico-legal autopsy: knowledge, attitude, and practices of doctors in Pakistan. J Ayub Med Coll Abbottabad. 2021;33(2):242–245.
10. Ali M, Talpur MGA, Qazi SAF. Medico-legal evaluation of firearms injury cases in the hospital emergency unit in Hyderabad, Pakistan: a retrospective survey. J Peoples Univ Med Health SciNawabshah. 2020;10(4):100–105.
11. Punjab Health Department. Annual Health Statistics Report 2023. Lahore: Department of Health, Government of Punjab; 2023.
12. World Health Organization. Global status report on violence prevention 2021. Geneva: WHO Press; 2022.
13. Giraudo C, Gibelli D, Cattaneo C. Forensic imaging in gunshot wound cases: the value of radiology in medicolegal investigations. Radiol Med. 2021;126(9):1161–1172.
14. Hassan Q, Imran R, Ali MA. Pattern and outcome of firearm injuries: A retrospective study at tertiary care hospital in Karachi. J Pak Med Assoc. 2021;71(6):1570–74.
15. United Nations Office on Drugs and Crime. Global Study on Homicide 2023. Vienna: UNODC; 2023.
16. Egger C, Flach P, Doenz F, et al. Accuracy of PMCT in detection of gunshot wounds: A 10-year retrospective study. Int J Legal Med. 2021;135(3):911–19.
17. Gascho D, Thali MJ, Christe A. Postmortem imaging of gunshot injuries: The complementary role of CT and MRI. Forensic Sci Med Pathol. 2020;16(1):70–81.
18. Polacco MA, Davidson TB, Wycoff SA, et al. Limitations of postmortem imaging in non-enhanced studies. Radiol Case Rep. 2021;16(3):657–63.
19. Yen K, Vock P, Christe A, et al. Postmortem CT vs. autopsy in firearm deaths. Forensic Sci Int. 2022;330:111099.
20. Wichmann D, Vogel H, Vock P. Multicenter evaluation of postmortem CT and autopsy correlation in GSW fatalities. J Forensic Radiol Imaging. 2022;30:200439.
21. Baloch Z, Iqbal A, Ahmed M. Radiology infrastructure in forensic practice: Challenges in Pakistan. Pak J Forensic Med. 2023;4(1):17–22.
22. Saeed A, Abbas F. Religious and social barriers to autopsies in South Asia. Ethics Med. 2021;37(2):58–65.
23. Shiotani S, Kohno M, Ohashi N. The role of Ai (autopsy imaging) in forensic medicine in Japan. Legal Med (Tokyo). 2021;49:102054.
24. Pakistan Bureau of Statistics. Annual Crime and Mortality Report 2023. Islamabad: PBS; 2023.
25. Zafar M, Khan F, Shahid A. Toward forensic radiology integration in Pakistan: A policy proposal. Health Syst Rev. 2024;5(2):101–09.