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Virtual Autopsy in Trauma Case: A retrospective study from a Tertiary Care Institute

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A B S T R A C T

INTRODUCTION: Background: The application of virtual autopsy (virtopsy), which employs imaging modalities like non-contrast computed tomography (NCCT) and X-rays, is increasingly gaining relevance in forensic pathology. This approach provides a non-invasive adjunct or alternative to traditional autopsy, particularly useful in trauma cases where radiological visualization of internal injuries enhances diagnostic accuracy.

OBJECTIVE: To evaluate the utility and findings of virtual autopsy in trauma-related deaths at a tertiary care institute over a defined period.

METHODS: A retrospective descriptive study was conducted on 139 trauma cases subjected to virtual autopsy at a tertiary care hospital between 2022 and 2024. Imaging modalities such as NCCT of the head, chest, abdomen, and extremities, along with digital radiography, were used. Patient demographics, type of injuries, imaging modalities used, and probable cause of death were analyzed.

RESULTS: Of the 139 cases, 85.6% were male and 14.4% female. The majority of victims were in the 20– 40 year age group. Head trauma was the most common injury pattern observed (67.6%), followed by thoracic (33.1%) and abdominal injuries (22.3%). Commonly identified injuries included skull fractures, intracranial hemorrhages (SAH, SDH, IVH), rib fractures, liver lacerations, pelvic fractures, and long bone fractures. NCCT Head was the most frequently used imaging tool (90.6%). The leading causes of death were severe head injury (48.2%), hemorrhagic shock due to internal injuries (29.4%), and cardiopulmonary arrest (19.4%).

CONCLUSION: Virtual autopsy in trauma cases provides crucial insights into injury patterns and cause of death. It offers a non-invasive, reliable, and complementary method to conventional autopsy, especially when medico-legal and ethical concerns arise or traditional dissection is not feasible. Radiological assessment enhances forensic documentation and supports legal investigations.

Keywords: Virtual autopsy, Virtopsy, Trauma cases, Tertiary care hospital.

INTRODUCTION:

Trauma-related fatalities represent a substantial proportion of medico-legal autopsies conducted globally, particularly in low- and middle-income countries where road traffic accidents and occupational injuries are prevalent. Determining the precise cause and mechanism of death in trauma victims is vital for medico-legal certification, legal proceedings, and epidemiological surveillance. Traditionally, autopsies involve dissection and internal examination of the body, which, while thorough, may be limited by cultural, religious, or logistical challenges (1).

This study presents a retrospective analysis of trauma-related deaths subjected to virtual autopsy at a tertiary care institute. It aims to analyze imaging findings, injury patterns, and establish the relevance of virtual autopsy in determining the cause of death.

MATERIALS AND METHODS

This retrospective descriptive study was conducted in the Department of Forensic Medicine at Government Medical College, Rajouri, Jammu and Kashmir. The study included 139 trauma-related fatalities over a two year period (April 2023-March 2025) that underwent virtual autopsy.

Inclusion criteria encompassed all trauma victims subjected to NCCT and/or digital radiogry post-mortem, with complete records and imaging findings. Cases with incomplete documentation or absent imaging were excluded.

Data collected included age, sex, year of incident, types of imaging conducted (e.g., NCCT head, chest, abdomen; X-rays), injury patterns identified, and the final documented cause of death.

Imaging was performed using a multi-slice NCCT scanner for head, chest, and abdominal regions and standard X-ray equipment for limb and skeletal evaluations. Interpretations were done by certified radiologists in collaboration with forensic pathologists.

Descriptive statistics were employed to analyze the data. Frequencies and percentages were used to summarize categorical variables, and trends across injury types and causes of death were analyzed.

RESULTS

A total of 139 trauma-related virtual autopsies were conducted during the study period. The majority of decedents were males (85.6%), with a male-to-female ratio of approximately 6:1. Most cases (61.8%) belonged to the 20– 40 year age group, indicative of high vulnerability in the economically active population.

The most frequently utilized imaging modality was NCCT Head (used in 90.6% of cases), followed by NCCT Chest (39.5%) and NCCT Abdomen (18.7%). Long bone and pelvic fractures were assessed via X-rays. Many cases had multiple imaging modalities used in combination.

Table 1 shows the various imaging modalities used for Virtual autopsy.

Table 1: Imaging Modality Utilization

Imaging Modality	Frequency (n=139)	Percentage (%)
NCCT Head	126	90.6
NCCT Chest	55	39.5
NCCT Abdomen	26	18.7
X-ray Lower Limbs	48	34.5
X-ray Skull	29	20.9
X-ray Pelvis & Spine	16	11.5

Head trauma was the most prevalent injury pattern (67.6%), followed by thoracic (33.1%), long bone fractures (28.8%), abdominal injuries (22.3%), and pelvic injuries (10.1%). Skull fractures and intracranial hemorrhages were the predominant findings in fatal head injuries as highlighted in Table 2.

Table 2: Distribution of Injury Patterns

Injury Type	Number of Cases	Percentage (%)
Skull fractures & Head trauma	94	67.6
Rib fractures & Chest trauma	46	33.1
Liver/spleen laceration	18	12.9
Pelvic fractures	14	10.1
Long bone fractures	40	28.8
Spinal injuries	7	5.0

The leading cause of death was severe head injury (48.2%), followed by hemorrhagic shock due to internal bleeding (29.4%) and cardiopulmonary arrest (19.4%). In a minority of cases (2.8%), multiple organ failure was documented as shown in Table 3.

Table 3: Probable Cause of Death

Cause of Death	Number of Cases	Percentage (%)
Severe head injury	67	48.2
Hemorrhagic shock	41	29.4
Cardiopulmonary arrest (CPA)	27	19.4
Multiple organ failure	4	2.8

DISCUSSION

The integration of virtual autopsy (virtopsy) in forensic investigations, particularly in trauma cases, has gained momentum over the last two decades. This study, based on 139 trauma-related deaths evaluated using virtopsy, underscores its utility in identifying injury patterns and probable causes of death with a high degree of accuracy.

The predominance of male victims (85.6%) and the concentration of fatalities in the 20– 40 year age group mirror findings from other trauma-related autopsy studies in low- and middle-income countries, where road traffic accidents and occupational injuries disproportionately affect young adult males [1– 3]. This demographic trend has significant public health implications, considering the loss of individuals in their most productive years

NCCT of the head was the most frequently utilized imaging modality (90.6%), which aligns with the high incidence of head trauma (67.6%) in this cohort. The findings emphasize the critical importance of neuroimaging in trauma cases, as it helps detect skull fractures, subdural hematomas, subarachnoid hemorrhages, and brain contusions— injuries often fatal if left undiagnosed [4– 6]. Previous studies have also shown that CT scans are superior in detecting skeletal and cranial injuries compared to conventional autopsy, particularly when soft tissue dissection is limited [7– 9].

Thoracic injuries (33.1%) and abdominal injuries (22.3%) were also frequently identified, with rib fractures and liver lacerations being common findings. In such cases, NCCT Chest and Abdomen provided critical insights, facilitating the detection of internal hemorrhage and organ trauma, which are otherwise challenging to visualize externally [10– 12]. These findings are consistent with prior research suggesting that virtual autopsy may offer improved detection of thoracoabdominal trauma, especially when integrated with angiographic imaging [13,14].

Importantly, this study found that severe head injury (48.2%) and hemorrhagic shock (29.4%) were the leading causes of death, reinforcing the diagnostic potential of virtopsy in establishing the mechanism of death without invasive procedures. In some instances, especially in medico-legal or religiously sensitive scenarios where traditional autopsy is denied or resisted, virtual autopsy has served as a reliable alternative [15,16].

Another notable advantage is the ability to document findings digitally and preserve them indefinitely, aiding in legal investigations and educational purposes [17,18]. However, the study also reveals certain limitations. Soft tissue injuries, vascular lesions, and histopathological changes are not always adequately captured through imaging modalities alone. Therefore, while virtopsy holds significant promise, it should be seen as a complementary tool rather than a replacement for conventional autopsy in all cases [19– 21].

Despite these limitations, the results highlight that virtual autopsy is a practical and non-invasive method that can augment conventional forensic practices. It is especially beneficial in mass casualty events, infectious disease outbreaks, or when rapid assessment is required without compromising body integrity [22– 25].

CONCLUSION

Virtual autopsy represents a transformative advancement in forensic medicine, offering a non-invasive, accurate, and reproducible method of evaluating trauma-related deaths. In this study of 139 trauma cases, virtopsy successfully identified major injury patterns and provided vital information to ascertain the cause of death, particularly in cases of head trauma and internal hemorrhage. Its utility is especially relevant in medico-legal contexts where traditional autopsy is limited by social, cultural, or logistical constraints.

As imaging technologies become more accessible and affordable, the integration of virtopsy into routine forensic investigations, alongside conventional autopsy, holds great promise for enhancing diagnostic accuracy, improving legal documentation, and upholding ethical considerations. Further multicentric studies and the development of standardized imaging protocols are recommended to optimize its application in the forensic setting.

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