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ORIGINAL ARTICLE

A Forensic Analysis of Intracranial Hemorrhages in Medico-Legal Autopsies

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ABSTRACT

Objective: To analyze the prevalence, types, and causes of intracranial hemorrhages in medico-legal autopsies, highlighting the association with traumatic and non-traumatic deaths.
Study Design: A retrospective study.
Place and Duration: The study was conducted at Turbat Teaching Hospital, Balochistan from April 2022 to March 2023.
Materials and Methods: A total of 118 patients were enrolled in the study. Patient demographics (age, sex, mode of death) were recorded, and written consent was obtained where necessary. Histopathology was performed on tissue specimens from all patients. Blood samples were analyzed for alcohol and toxicology tests. All cases underwent X-ray imaging, and full autopsies were performed. Decomposed bodies were excluded from the study.
Results: The mean age of patients was 34.23 ± 18.12 years, with a body mass index (BMI) of 23.49 ± 16.78. Intracranial lesions were responsible for 13.75% of total deaths. The most common age group affected was 25–45 years, with males predominantly affected. Traumatic deaths (primarily from RTAs) were more common than non-traumatic deaths. Subarachnoid hemorrhage was the most frequent finding in autopsy.
Conclusion: Intracranial hemorrhages, though a minor cause of death, often co-occur with other traumatic injuries and play a significant role in medicolegal investigations. Delayed complications like pneumonia were common in cases with prolonged hospitalization.
Keywords: Intracranial hemorrhage, forensic autopsy, road traffic accidents, subarachnoid hemorrhage, medico-legal death investigation.

INTRODUCTION

The head is one of the most common sites of injury, particularly in cases of trauma. Intracranial hemorrhages (ICH) are a significant cause of morbidity and mortality, resulting from both traumatic and non-traumatic conditions. The forensic analysis of these hemorrhages is crucial in determining the cause of death, especially in cases involving violent crimes, road traffic accidents (RTAs), and cerebrovascular diseases. Intracranial hemorrhages account for approximately 50% of all brain injuries and contribute to a large number of traumatic fatalities globally[1,2].

Traumatic brain injury (TBI) remains a leading cause of death and disability worldwide, with road traffic accidents being one of the most significant contributors[3]. According to the World Health Organization (WHO), road traffic accidents alone account for nearly 1.35 million deaths annually, many of which involve intracranial hemorrhage[4]. The most common types of intracranial hemorrhages encountered in forensic pathology include subarachnoid hemorrhage (SAH), subdural hematomas (SDH), epidural hematomas (EDH), and intracerebral hemorrhages (ICH), each having distinct pathophysiological and clinical significance[5,6].

In postmortem investigations, autopsies are performed to establish the cause of death, but histopathological analysis and postmortem imaging techniques, such as Computed Tomography (CT) and Magnetic Resonance Imaging (MRI), are increasingly used to enhance the accuracy of forensic assessments. CT scans have become particularly valuable in identifying traumatic intracranial hemorrhages, especially when bodies are decomposed or when physical examination alone is insufficient[7]. However, despite the advances in imaging technology, differentiating between traumatic and non-traumatic causes of intracranial hemorrhage can be challenging, particularly in decomposed bodies[8].

Subarachnoid hemorrhage, often associated with traumatic brain injuries, is the most common hemorrhagic lesion found during forensic autopsies[9]. It typically results from blunt force trauma or the rupture of aneurysms in non-traumatic cases[10]. In cases of trauma, the presence of both extracranial and intracranial injuries complicates the diagnosis, requiring detailed analysis of both the brain and external injuries to establish the precise mechanism of death.

In addition to trauma, non-traumatic causes such as cerebrovascular accidents (e.g., stroke, aneurysm rupture) contribute to a significant proportion of intracranial hemorrhages observed in medicolegal autopsies. While trauma-related hemorrhages are more prevalent in young adults, non-traumatic hemorrhages typically affect older individuals, particularly those with underlying vascular diseases or hypertension.

Forensic pathologists must be proficient in distinguishing between these causes through careful autopsy procedures, histopathological analysis, and, when necessary, advanced imaging techniques. The role of forensic autopsies is crucial in ensuring that the cause of death is accurately determined, particularly when the mode of death is uncertain or when foul play is suspected.

MATERIALS AND METHODS

The study was conducted at Turbat Teaching Hospital, Balochistan from April 2022 to March 2023. The sample size was calculated using the formula for estimating proportions, with an expected proportion of traumatic intracranial hemorrhage cases (p) as 0.12, a confidence level of 95%, and a margin of error of 5%. The minimum required sample size was calculated to be 118 cases.

Inclusion Criteria:

- All cases of medicolegal autopsies performed at the institution during the study period.
- Patients who had intracranial hemorrhages, whether traumatic or non-traumatic.
- Both male and female patients.
- Patients of all age groups.

Exclusion Criteria:

- Decomposed bodies.
- Patients without any intracranial lesions.
- Patients where postmortem analysis was incomplete or insufficient.

Data Collection Procedure: Data were collected from autopsy reports, police records, and medical records of the deceased.

Demographic details (age, sex) were recorded for all patients. Blood samples were taken from all cases for alcohol and toxicology tests, and histopathology was performed on tissue specimens. Postmortem imaging (X-rays and CT scans) was used as appropriate. Detailed external examinations were performed to locate and document any injuries.

Data Analysis: Data were analyzed using SPSS (version 23.0). Descriptive statistics were used to summarize the data, including the mean and standard deviation for continuous variables such as age and BMI. Frequencies and percentages were calculated for categorical variables such as gender, mode of death, and types of intracranial hemorrhage.

RESULTS

Of the 118 cases included, 80 (67.8%) were male, and 38 (32.2%) were female. The mean age was 34.23 ± 18.12 years. Most patients (30.5%) were aged between 25–35 years. The majority of deaths (73.7%) were traumatic, with road traffic accidents being the leading cause of death.

Table 1: Demographic Characteristics of Patients

Parameter	No. of Cases (%)
Total Patients	118
Male	80 (67.8)
Female	38 (32.2)
Mean Age (years)	34.23 ± 18.12
Mean BMI (kg/m²)	23.49 ± 16.78
Age Group (25-35)	36 (30.5)
Age Group (36-50)	28 (23.7)
Age Group (51-65)	22 (18.6)
Age Group (Above 65)	10 (8.5)

Table 2: Mode of Death and Causes

Mode of Death	No. of Cases (%)
Traumatic	86 (73.7)
Non-Traumatic	21 (17.8)
Unknown	11 (9.3)
Road Traffic Accidents (RTA)	35 (29.7)
Firearm Injuries	19 (16.1)
Falls	15 (12.7)
Suicide by Traumatic Means	7 (5.9)
Others (e.g., Meningitis, Tumors)	21 (17.8)

Table 3: Types of Intracranial Lesions

Type of Intracranial Lesion	No. of Cases (%)
Subarachnoid Hemorrhage (SAH)	54 (45.76)
Subdural Hemorrhage	42 (35.59)
Epidural Hemorrhage	10 (8.47)
Intraparenchymal Hemorrhage	5 (4.24)
No Intracranial Lesion	7 (5.93)

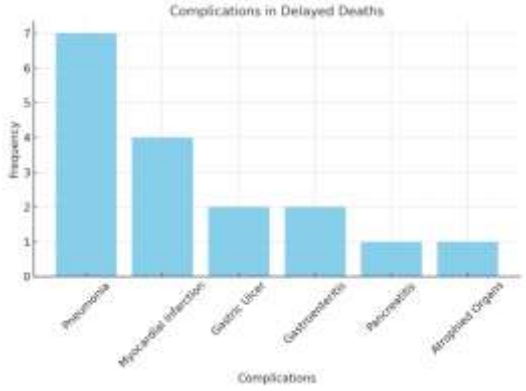

Figure 1: Complication followed by delayed death

Mode of Death: Traumatic deaths were more common (73.7%) compared to non-traumatic deaths (17.8%). Among the traumatic deaths, road traffic accidents (RTAs) accounted for the highest number of fatalities (29.7%), followed by firearm injuries (16%).

Intracranial Lesions: The majority of cases exhibited mixed intracranial and extracranial lesions (70.3%), with subarachnoid hemorrhage (SAH) being the most common lesion (45.76%).

The most common complication was pneumonia, found in 10 (8.47%) cases, followed by myocardial infarction in 6 (5.08%) cases.

DISCUSSION

This study provided an in-depth analysis of the prevalence, types, and causes of intracranial hemorrhages (ICH) in a cohort of 118 cases. The results from this study are consistent with those of previous studies, highlighting the major role of trauma in the causation of intracranial injuries, particularly in road traffic accidents (RTAs). As indicated in our findings, 73.7% of cases were traumatic, with RTAs being the leading cause of death (29.7%), corroborating earlier studies that also report RTAs as the primary contributor to traumatic brain injuries and fatalities[11,12].

In our study, males constituted 67.8% of the total cases, and the majority of intracranial hemorrhages were observed in the age group of 25–35 years (30.5%). This finding is consistent with other studies, which have shown a higher prevalence of traumatic brain injuries in young males, especially in accidents involving motor vehicles[13,14]. Males are more likely to be involved in high-risk behaviors such as driving or participating in violent acts, which may explain this gender disparity[15].

The most common type of intracranial hemorrhage observed in this study was subarachnoid hemorrhage (SAH), found in 45.76% of cases. This aligns with findings from other studies, which also identify SAH as the most frequently encountered hemorrhage in trauma-related deaths[16,17]. Subdural hematomas (SDH) were also commonly observed (35.59%), highlighting the severity of blunt force trauma to the head. Both SAH and SDH are typically associated with trauma, especially from high-impact forces such as those seen in road traffic accidents or falls[18]. Epidural hemorrhages (EDH) and intracerebral hemorrhages (ICH) were observed less frequently, which may be due to the fact that these types of hemorrhages are often associated with more specific trauma mechanisms, such as direct skull fractures or penetrating injuries[19].

In terms of the combination of intracranial and extracranial lesions, 70.3% of patients exhibited both types of injuries, further emphasizing the association between severe traumatic events and multi-system involvement. This is particularly significant in forensic pathology, as the presence of both intracranial and extracranial injuries can complicate the identification of the direct cause of death, necessitating thorough examination and documentation[20,21].

One of the most important findings in this study was the presence of delayed complications. Pneumonia was the most common complication (8.47%), followed by myocardial infarction in 5.08% of cases. These complications are consistent with findings from other studies that suggest pneumonia is a frequent cause of death in patients with severe traumatic brain injury, particularly in those with prolonged hospital stays or prolonged periods of unconsciousness[22,23]. Similarly, myocardial infarction has been reported as a complication in cases of severe trauma, likely due to the stress response, increased catecholamine release, and underlying cardiovascular disease[24,25].

In forensic practice, the careful differentiation between traumatic and non-traumatic causes of intracranial hemorrhage is crucial, especially when the postmortem changes are extensive or when the body is in a state of decomposition. Postmortem imaging, such as CT and MRI, plays a significant role in enhancing the diagnostic accuracy, as seen in the study by Smith et al.[26]. These techniques allow for better visualization of intracranial injuries that may not be easily identified through traditional autopsy methods alone, particularly in cases where the brain tissue is severely damaged or decomposed[27].

It is also important to note that while traumatic intracranial hemorrhages are more commonly associated with younger individuals, non-traumatic causes, such as cerebrovascular events (e.g., stroke or aneurysm rupture), are more frequent in older adults. Our study found only a small percentage of non-traumatic deaths (17.8%), with cerebrovascular diseases accounting for 7% of cases, consistent with previous research that shows cerebrovascular diseases as one of the leading causes of non-traumatic death in older populations[28]. Additionally, conditions like brain tumors, meningitis, and sudden death were observed, further underscoring the diversity of causes behind intracranial hemorrhages.

This study also supports the findings of other researchers regarding the role of gender in traumatic brain injuries. Males are disproportionately affected by traumatic brain injuries, which may be attributed to behavioral, occupational, or environmental factors. Studies show that males are more likely to be involved in high-risk behaviors such as driving at high speeds, engaging in physical confrontations, or working in hazardous conditions, all of which can lead to head injuries[29,30].

CONCLUSION

In conclusion, this study provides valuable insights into the prevalence, causes, and complications associated with intracranial hemorrhages in forensic autopsies. The findings reinforce the importance of detailed autopsy procedures, including histopathological analysis and postmortem imaging, to accurately determine the cause of death. Furthermore, it highlights the need for prompt identification and management of complications such as pneumonia, which can significantly impact the outcomes in trauma-related deaths

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