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A Comparative Study of Postmortem Blood and Vitreous Humor Toxicology in Suspected Poisoning Cases.

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ABSTRACT

Postmortem toxicology is essential in determining the cause of death in suspected poisoning cases. Blood is commonly used for toxicological analysis; however, it may be unreliable due to postmortem changes. Vitreous humor, being chemically stable and less prone to contamination, may serve as a valuable alternative. To compare the toxicological findings in postmortem blood and vitreous humor samples in suspected poisoning cases and evaluate the diagnostic concordance between the two specimens. A total of 52 medicolegal autopsy cases with suspected poisoning were included in this comparative study. Blood and vitreous humor samples were collected during autopsy and analyzed using standard toxicological techniques including gas chromatography-mass spectrometry (GC-MS). Data on poison detection rates and concordance between fluids were statistically analyzed. Poison was detected in 80.8% of blood samples and 86.5% of vitreous humor samples. Concordant detection in both fluids was seen in 76.9% of cases. Organophosphates and aluminum phosphide were the most frequently detected poisons, with the highest concordance observed in aluminum phosphide (100%). Vitreous humor is a reliable alternative to blood for postmortem toxicological analysis and may enhance diagnostic accuracy in forensic investigations, especially in decomposed bodies.

Keywords: Postmortem toxicology, vitreous humor, suspected poisoning

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INTRODUCTION

Poisoning remains a significant cause of morbidity and mortality worldwide, with postmortem toxicological analysis playing a crucial role in establishing the cause and manner of death [1]. In forensic investigations, accurate identification and quantification of toxic substances are essential for confirming suspected poisoning cases [2-4]. Blood is the most commonly analyzed biological fluid due to its systemic distribution of toxins. However, postmortem blood is often subject to putrefaction, redistribution of drugs, and contamination, which can compromise its reliability [5].

Vitreous humor, the clear gel found in the posterior chamber of the eye, offers several advantages over blood in postmortem toxicology. It is relatively resistant to postmortem changes, less prone to contamination, and remains chemically stable for longer periods after death. This makes it a valuable alternative specimen, especially in decomposed or exhumed bodies [6, 7].

Our study aims to compare the toxicological findings in postmortem blood and vitreous humor samples in suspected poisoning cases.

METHODOLOGY

Our comparative study was conducted in the Department of Forensic Medicine at a tertiary care center over a period of one year. A total of 52 suspected poisoning cases brought for medicolegal autopsy were included. Cases were selected based on a history of suspected poisoning provided by the investigating agencies, circumstantial evidence, or clinical suspicion prior to death. Only cases with adequate postmortem preservation and available blood and vitreous humor samples were included. Cases with advanced decomposition, traumatic injuries to the eye, or insufficient sample volume were excluded from the study.

During the postmortem examination, blood samples were collected from the femoral vein using sterile syringes to minimize contamination and postmortem redistribution. Approximately 10 ml of blood was drawn into fluoride-oxalate and plain vials for chemical and toxicological analysis. Simultaneously, vitreous humor was aspirated from both eyes using a sterile 18-gauge needle and syringe, yielding approximately 2–3 ml per eye. All samples were immediately stored in sealed, properly labeled containers and transported to the forensic toxicology laboratory under cold chain maintenance.

Both blood and vitreous humor samples underwent comprehensive toxicological screening for common poisons, including organophosphates, aluminum phosphide, barbiturates, alcohol, and pesticides. Standard colorimetric, chromatographic, and enzymatic methods were used, and gas chromatography-mass spectrometry (GC-MS) was employed for confirmatory analysis. The results were interpreted by trained forensic toxicologists who were blinded to the sample type to avoid bias.

The findings from blood and vitreous humor analyses were recorded and compared to assess the detectability, concentration, and consistency of the toxins. Descriptive statistics were applied to analyze the frequency of detection, and concordance rates were calculated. The study aimed to determine the reliability of vitreous humor as a biological specimen for postmortem toxicology and its potential role in improving diagnostic accuracy in suspected poisoning cases.

RESULTS

Table 1: Age and Gender Distribution of Suspected Poisoning Cases (n = 52)

Age Group (Years)	Male (n)	Female (n)	Total (n)	Percentage (%)
<20	3	4	7	13.5
21–30	9	6	15	28.8
31–40	8	4	12	23.1
41–50	6	2	8	15.4
>50	6	4	10	19.2
Total	32	20	52	100

Table 2: Distribution of Types of Poisons Detected (in any sample)

Type of Poison	No. of Cases (n)	Percentage (%)
Organophosphates	14	26.9
Aluminum Phosphide	10	19.2
Ethanol	8	15.4
Barbiturates	5	9.6
Unknown/Unidentified	7	13.5
No Poison Detected	8	15.4
Total	52	100

Table 3: Comparison of Detection Rates in Blood vs. Vitreous Humor

Sample Type	Positive Cases (n)	Detection Rate (%)
Blood Only	42	80.8
Vitreous Only	45	86.5
Both Positive	40	76.9
Discordant Cases	5	9.6

Table 4: Concordance between Blood and Vitreous Humor for Poison Detection

Type of Poison	Blood Positive	Vitreous Positive	Concordant Cases	Concordance (%)
Organophosphates	14	13	12	85.7
Aluminum Phosphide	10	10	10	100
Ethanol	6	8	6	75
Barbiturates	4	5	4	80
Unknown	5	4	2	40

Discussion

In this comparative study involving 52 suspected poisoning cases, we aimed to evaluate the diagnostic reliability of vitreous humor toxicology in comparison to traditional postmortem blood analysis. The study findings provide valuable insights into the relative detectability, consistency, and applicability of vitreous humor as a biological fluid in forensic toxicology.

The age and gender distribution (Table 1) revealed that the majority of cases occurred in the 21–30 years age group (28.8%), followed by the 31–40 years group (23.1%). This pattern is consistent with national epidemiological trends in poisoning, which often show higher incidence among young adults due to occupational exposures, stress-related suicidal attempts, and accidental ingestion. Males constituted a higher proportion (61.5%) compared to females (38.5%), likely reflecting greater risk-taking behavior and access to toxic substances [8].

Table 2 highlights the types of poisons detected, with organophosphates (26.9%) and aluminum phosphide (19.2%) being the most prevalent, followed by ethanol and barbiturates. These findings are in agreement with studies from rural India, where organophosphate pesticides and phosphides are commonly used in agriculture and often implicated in suicidal poisonings. The high percentage of cases with no poison detected (15.4%) emphasizes the importance of timing of sample collection, limitations of screening tests, or the possibility of non-toxicological causes of death.

The detection rates in blood and vitreous humor (Table 3) suggest that vitreous humor had a slightly higher positivity rate (86.5%) compared to blood (80.8%). Interestingly, 76.9% of cases showed concordant positivity in both fluids, while 9.6% of cases showed discordance. This reinforces the notion that vitreous humor can serve as a reliable and, in some situations, superior alternative when blood is unavailable or compromised due to putrefaction or postmortem redistribution [9, 10].

The concordance analysis (Table 4) further supports the role of vitreous humor in postmortem toxicology. Aluminum phosphide showed complete concordance (100%) between blood and vitreous humor, reflecting the stability and systemic distribution of this compound. Organophosphates showed a

high concordance rate of 85.7%, whereas ethanol and barbiturates had slightly lower agreement (75% and 80%, respectively). These variations could be attributed to the differences in chemical properties, such as volatility, lipophilicity, and protein binding, which affect their diffusion into ocular tissues. Unknown or unidentified substances showed the lowest concordance (40%), underscoring the limitations in detecting non-standard poisons or degraded products [11].

Overall, our results indicate that vitreous humor is a viable specimen for toxicological evaluation, particularly in decomposed bodies or where blood is not retrievable. Its anatomical isolation protects it from external contamination and redistribution phenomena. Additionally, vitreous humor offers a chemically stable matrix, making it suitable for both qualitative and quantitative analyses.

CONCLUSION

In conclusion, our study highlights the complementary role of vitreous humor in forensic toxicology. While blood remains the primary specimen due to its systemic nature, vitreous humor provides a reliable backup, often yielding similar or superior detection results. Incorporating vitreous analysis into routine autopsy protocols may improve the diagnostic accuracy in suspected poisoning cases, especially under challenging postmortem conditions. Further large-scale studies with advanced analytical techniques are recommended to validate these findings and develop standardized guidelines for multi-specimen toxicological investigations.

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