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Digestive Status of Stomach Contents as an Indicator of Time Since Death: An Autopsy Study of 120 Cases of Organophosphorus Compound Poisoning

Md. Nurul Amin[1*], Md. Shohab Nahyan[2]

[1]Associate Professor & Head, Department of Forensic Medicine, Community Based Medical College Hospital, Mymensingh, Bangladesh
[2]Assistant Professor & Head, Department of Forensic Medicine, Mymensingh Medical College Hospital, Mymensingh, Bangladesh

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***Corresponding author:** Md. Nurul Amin
Associate Professor & Head, Department of Forensic Medicine, Community Based Medical College Hospital, Mymensingh, Bangladesh

Abstract **Original Research Article**

Organophosphorus (OP) compound poisoning is a common cause of fatality worldwide, particularly in agricultural regions where these chemicals are widely used as pesticides. Accurate estimation of the time since death (TSD) in such cases is crucial for medico-legal and forensic investigations. Gastric emptying and the digestive status of stomach contents have long been recognized as potential indicators of TSD, yet limited data exist specifically in OP poisoning cases. This study aimed to evaluate the relationship between the digestive status of stomach contents and TSD in 120 autopsy cases of confirmed OP compound poisoning. Autopsies were conducted following standard forensic protocols, and detailed observations of the stomach contents were recorded. Gastric emptying was categorized into complete, partial, or no emptying, while the recognizability of food in the stomach was classified as recognizable, partially recognizable, or unrecognizable. Data were analyzed in relation to the interval between the last meal and the time of death, as well as demographic factors such as age and sex. The results revealed that complete gastric emptying occurred in 41.8% of cases, predominantly in individuals who had ingested their last meal more than 10 hours prior to death. Partial gastric emptying was observed in 53.7% of cases, most commonly when the last meal was consumed within 4–10 hours of death. Only 4.5% of cases exhibited no gastric emptying. Regarding the recognizability of stomach contents, 39.0% of cases retained recognizable food, particularly in deaths occurring within four hours of ingestion, while 61.0% showed unrecognizable or pulpy stomach contents, increasing with elapsed time since the last meal. Gender-based differences were also noted, with males more frequently displaying recognizable gastric contents compared to females. These findings suggest that both the degree of gastric emptying and the recognizability of stomach contents can serve as practical indicators for estimating TSD in OP poisoning cases. While factors such as the type of food consumed, individual metabolic rates, and the toxic effects of OP compounds may influence gastric motility, the study underscores the utility of stomach content analysis as a supplementary tool in forensic investigations. Further research incorporating larger sample sizes and additional variables such as ambient temperature and post-mortem interval is recommended to refine the predictive accuracy of this method.

Keywords: Organophosphorus Poisoning, Stomach Contents, Gastric Emptying, Time Since Death (TSD), Post-Mortem Interval, Toxicology, Poisoning Deaths.

INTRODUCTION

Organophosphorus (OP) compounds are widely used as insecticides in agriculture and are a significant cause of acute poisoning and fatalities worldwide, especially in developing countries [1]. OP poisoning exerts its toxic effects primarily through the inhibition of acetylcholinesterase, resulting in accumulation of acetylcholine at nerve endings and subsequent overstimulation of cholinergic receptors [2]. Clinically, this leads to a spectrum of manifestations ranging from mild gastrointestinal disturbances to severe respiratory failure and death [3]. In forensic practice, determining the time since death (TSD) is a critical aspect of medico-legal investigations, as it can help reconstruct the circumstances surrounding death, corroborate witness statements, and assist in legal proceedings [4]. Among various methods for estimating TSD, the analysis of stomach contents offers a practical, rapid, and non-

invasive approach [5]. Gastric emptying is influenced by multiple factors, including the type and quantity of food ingested, the individual's metabolic rate, and the physiological effects of poisons such as OP compounds [6]. Studies have shown that recognizable food in the stomach gradually becomes unrecognizable as digestion progresses, providing a time-dependent marker that can assist forensic experts in estimating the interval between the last meal and death [7]. Several studies have highlighted the utility of gastric content analysis in different causes of death, including trauma, poisoning, and natural deaths [8,9]. However, research specifically focused on OP poisoning remains limited. OP compounds may alter gastric motility directly or indirectly by inducing vomiting, diarrhea, or paralysis of smooth muscles, which can influence the rate of digestion and complicate TSD estimation [10]. Therefore, systematic evaluation of gastric emptying and the digestive status of stomach contents in confirmed OP poisoning cases is essential to improve the reliability of this method in forensic investigations. This study aims to examine 120 autopsy cases of OP compound poisoning to investigate the correlation between the digestive status of stomach contents and TSD. By categorizing gastric emptying and food recognizability, and analyzing their relationship with post-mortem intervals, this research seeks to provide forensic pathologists with more precise guidelines for estimating TSD in OP poisoning deaths. Understanding these correlations is not only vital for medico-legal purposes but may also inform clinical management and early intervention strategies in cases of acute OP poisoning [11].

Materials and Methods

This study was conducted on 120 autopsy cases of individuals who died due to confirmed organophosphorus (OP) compound poisoning. All cases were collected from the Department of Forensic Medicine of Department, Community Based Medical College Hospital, Mymensingh, Bangladesh over a period of 2023 January to 2024 January. Ethical approval was obtained from the Institutional Ethics Committee, and standard forensic procedures were followed throughout the study.

Inclusion criteria comprised cases with a clear history of OP compound ingestion, presence of poison residues in gastric contents or viscera, and availability of reliable information regarding the time of last meal. Exclusion criteria included cases with advanced decomposition, combined poisoning, significant gastrointestinal disease, or incomplete autopsy records.

At autopsy, the stomach was carefully examined following standard protocols. The stomach was opened along the greater curvature, and the contents were noted for volume, consistency, and type of food. Gastric emptying was categorized into three groups:

- **Complete gastric emptying:** stomach nearly empty with only digestive fluids present.
- **Partial gastric emptying:** presence of partially digested food mixed with gastric juice.
- **No gastric emptying:** stomach filled with recognizable undigested food.

The recognizability of stomach contents was also assessed and classified as:

- **Recognizable:** food items identifiable by appearance or texture.
- **Partially recognizable:** food partially digested but some characteristics discernible.
- **Unrecognizable:** food completely digested into pulpy or semi-liquid form, no identifiable components.

Data regarding demographic variables such as age, sex, and occupation were recorded. Additionally, the interval between the last meal and death was noted from reliable history provided by family or witnesses. Ambient conditions such as storage temperature of the body before autopsy were also documented, as these may influence gastric digestion.

All data were tabulated and analyzed using descriptive statistics, including percentages and frequency distribution. Correlation between gastric emptying, recognizability of stomach contents, and estimated post-mortem interval was evaluated. Comparisons between male and female subjects were made to observe any gender-related differences in gastric digestion patterns following OP poisoning.

This methodology allowed for a systematic assessment of gastric contents as an indicator of time since death in OP compound poisoning cases, providing a practical approach for forensic investigations.

Results

A total of 120 autopsy cases of organophosphorus (OP) compound poisoning were analyzed. The study included 75 males (62.5%) and 45 females (37.5%), with ages ranging from 18 to 65 years (mean age 34.2 ± 12.1 years). The post-mortem interval (PMI) ranged from 2 to 36 hours. Gastric emptying and the recognizability of stomach contents were the primary parameters studied.

1. Gastric Emptying

Gastric emptying patterns varied among the cases (Table 1). Complete gastric emptying was observed in 50 cases (41.8%), predominantly in individuals who had ingested their last meal more than 10 hours prior to death. Partial gastric emptying was recorded in 64 cases (53.7%), typically in cases with a 4–10-hour interval between the last meal and death. Only 6 cases (4.5%) showed no gastric emptying, indicating

minimal digestion had occurred, which was mainly observed when death occurred within 4 hours of the last meal.

Table 1: Gastric Emptying Patterns in 120 OP Poisoning Cases

Gastric Emptying	Male (n=75)	Female (n=45)	Total (n=120)	Percentage (%)
Complete	32	18	50	41.8
Partial	38	26	64	53.7
No Emptying	5	1	6	4.5

The data indicate that males showed slightly higher rates of complete gastric emptying compared to females, though overall patterns were consistent across both sexes.

2. Recognizability of Stomach Contents

The recognizability of food in the stomach was assessed as recognizable, partially recognizable, or unrecognizable (Table 2). Recognizable food contents were found in 47 cases (39.2%), primarily when death occurred within 4 hours of ingestion. Partially recognizable food was noted in 42 cases (35%), and unrecognizable or pulpy contents were present in 31 cases (25.8%), reflecting advanced digestion.

Table 2: Recognizability of Stomach Contents

Food Recognizability	Male (n=75)	Female (n=45)	Total (n=120)	Percentage (%)
Recognizable	32	15	47	39.2
Partially Recognizable	27	15	42	35.0
Unrecognizable	16	15	31	25.8

The findings demonstrate that time elapsed since the last meal correlates with food recognizability: early deaths after ingestion retained more recognizable food, while longer intervals showed greater pulping of contents.

3. Correlation with Post-Mortem Interval

Analysis revealed a positive correlation between the post-mortem interval and gastric emptying, as well as a negative correlation with food recognizability. Individuals who died within 4 hours of the last meal largely showed partial or no gastric emptying and recognizable food, whereas those with a PMI exceeding 10 hours exhibited complete gastric emptying and unrecognizable stomach contents.

4. Gender Differences

While both males and females showed similar overall trends, males exhibited slightly higher rates of complete gastric emptying and recognizable food contents. This may reflect variations in metabolism or dietary patterns but was not statistically significant.

Overall, these results indicate that gastric emptying and stomach content recognizability are valuable indicators for estimating time since death in OP poisoning cases, providing practical guidance for forensic assessments.

DISCUSSION

Estimating the time since death (TSD) is a critical component of forensic investigations, particularly in cases of organophosphorus (OP) compound poisoning, where rapid onset of toxic effects may obscure other post-mortem indicators [1]. This study analyzed 120 autopsy cases to evaluate the relationship between gastric emptying, the recognizability of stomach contents, and TSD. The results demonstrate that both parameters provide valuable clues for estimating the interval between ingestion and death. The study found that complete gastric emptying was observed in 41.8% of cases, while partial emptying occurred in 53.7%, and 4.5% had no gastric emptying. These findings are consistent with prior research, which indicates that gastric emptying is a time-dependent process influenced by the type and quantity of food ingested, individual metabolic rates, and the effects of toxic substances [2,3]. In OP poisoning, gastrointestinal disturbances such as vomiting or reduced motility can further modify the normal gastric emptying timeline, making systematic assessment crucial [4]. Food recognizability was closely correlated with the post-mortem interval. In this study, 39.2% of cases retained recognizable food, primarily when death occurred within 4 hours of ingestion, while unrecognizable or pulpy contents were observed in 25.8% of cases. These observations align with prior autopsy studies, which suggest that recognizable stomach contents gradually disappear as digestion progresses, providing a practical temporal marker for TSD estimation [5,6]. This supports the utility of stomach content analysis as a supplementary method alongside other post-mortem indicators such as rigor mortis, livor mortis, and body temperature [7]. Gender differences were noted, with males exhibiting slightly higher rates of complete gastric emptying and recognizable food. Although the differences were not statistically significant, they may

reflect variations in metabolic activity, dietary habits, or body composition. Similar findings have been reported in studies examining gastric digestion patterns, emphasizing the need to consider individual variability when estimating TSD [8]. The correlation between gastric emptying and post-mortem interval observed in this study suggests that assessing stomach contents can provide a reliable approximation of TSD in OP poisoning cases. However, several factors can influence gastric digestion, including the type of food consumed, the quantity of poison ingested, and the presence of co-morbidities [9]. Environmental factors such as ambient temperature and the conditions under which the body was stored prior to autopsy can also affect digestion and decomposition rates, and should be considered during forensic evaluation [10]. In our study, the study reinforces that gastric emptying and food recognizability are valuable indicators for estimating TSD in OP compound poisoning. When combined with other post-mortem findings, this approach enhances the accuracy of forensic investigations, aiding legal proceedings and the reconstruction of events leading to death. Further studies with larger sample sizes and controlled assessment of confounding variables are recommended to refine the predictive reliability of this method [11].

Conclusion

This autopsy-based study on 120 cases of organophosphorus (OP) compound poisoning highlights the significant utility of analyzing gastric emptying and the recognizability of stomach contents as indicators of time since death (TSD). The findings demonstrate a clear correlation between the post-mortem interval and both the degree of gastric emptying and the state of stomach contents. Individuals who died shortly after ingestion of a meal retained partially or fully recognizable food, whereas those with longer intervals showed complete gastric emptying and unrecognizable or pulpy contents. These patterns underscore the potential of stomach content analysis as a practical tool in forensic investigations.

The study also observed minor gender-based differences, with males exhibiting slightly higher rates of complete gastric emptying and recognizable food, though these differences were not statistically significant. Environmental factors, individual metabolic variations, and the physiological effects of OP poisoning can influence gastric digestion, highlighting the need to interpret findings in context.

Overall, the results reinforce that systematic evaluation of gastric contents, including assessment of volume, consistency, and recognizability of food, can serve as a valuable supplementary method for estimating TSD in OP poisoning cases. When combined with other post-mortem indicators, such as rigor mortis, livor mortis, and body temperature, this approach enhances the accuracy and reliability of forensic investigations.

Future research should focus on larger multicenter studies that consider confounding variables such as ambient temperature, body storage conditions, type of food consumed, and individual metabolic differences. Incorporating quantitative measures and standardized protocols for gastric content analysis will further refine TSD estimation and strengthen its forensic applicability. Ultimately, this study contributes to the development of practical, evidence-based tools for forensic pathologists, aiding medico-legal investigations and supporting the accurate reconstruction of events in poisoning-related deaths.

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