

Estimation of Time since Death from Rigor Mortis, Postmortem Staining, and Decomposition: An Autopsy-Based Study in a Tertiary Care Hospital, Tripura

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ABSTRACT

Background: Thanatology is the branch of science which deals with all the aspects of death. Determining the time of death is a crucial aspect of forensic investigations. The present study aimed to estimate the time since death from rigor mortis, postmortem staining and decomposition.

Methods: Mortuary-based prospective cross-sectional study was conducted among 94 deceased autopsied at the Mortuary of the Department of Forensic Medicine and Toxicology, AGMC & GBPH Hospital for three months (April-June 2024). Statistics were performed accordingly by using IBM SPSS, version 25.

Results: The post-mortem staining was fully established and fixed in all cases within a time frame of 06 to 24 hours after death. Rigor mortis was observed throughout the entire body in all instances investigated during a time frame of 03 to 24 hours following death. Alterations in color due to decomposition were observed within a time frame of 24 to 36 hours in the iliac fossae, with a green hue present in 80% of instances. After 36 hours, the entire body exhibited a greenish-black color in 100% of cases.

Conclusion: The current study has determined that Rigor mortis, Post-mortem staining, and decomposition changes in deceased bodies are crucial for accurately estimating the range of time since death.

Key-words: Autopsy, Death, Decomposition, Postmortem staining, Rigor Mortis, Thanatology

INTRODUCTION

The scientific field of thanatology studies every aspect of death. Clinical death is typically followed by brain death, biological death, and ultimately cellular death. Following death, a variety of physico-chemical processes including rigor mortis, postmortem hypostasis, and decomposition take place, causing all soft tissues to dissolve. These alterations are significant because they follow a predictable pattern and can be utilised to calculate the approximate period since death ^[1].

Muscles in rigor mortis tighten, occasionally with a small shortening of the fibres. At this point, individual cells begin to die. When all ATP molecules are used up, the actino-myosin complex permanently cross-links to create it. Nysten's rule is that it initially manifests in involuntary muscles. Within an hour, the myocardium stiffens. Externally, it starts in the muscles of the eyelids, neck, and lower jaw, moves up to the face's muscles, moves down to the muscles of the chest, upper limbs, abdomen, and lower limbs, and ends in the fingers and toes. Usually, it moves downwards from above in individual limbs. A sequence like that is regular or symmetrical. It vanishes in each limb in the same sequence as it first emerged. The eyes (02 hours), jaw (03 hours), upper limb (06 hours), lower limb (09 hours), fingers, and toes (12 hours) are the first areas of voluntary muscle to exhibit rigor mortis. Within 12 hours,

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rigor mortis is established throughout the body, lasts for an additional 12 hours, and then passes away in the following 12 hours ^[2].

Postmortem staining is the term used to describe the purplish or reddish-purple regions of discolouration in the body's dependant areas that appear through the skin as a result of accumulated fluid blood in the vessels after death. In plethoric subjects, it often manifests 30 minutes–01 hour after death, however in anaemic subjects, it takes up to 04 hours. Over 06–10 hours, the patches progressively coalesce to produce a sizable area of reddish-purple discolouration ^[3]. It begins as spotted patches that take 30 minutes–02 hours to develop, fully established into a sheet but is not fixed till 04 hours, becomes fully developed and fixed within 06–12 hours, and continues until putrefaction sets in ^[4].

Putrefaction and autolysis are the two processes involved in decomposition. Autolysis is the breakdown of tissues by themselves. Cell membranes soon after death degrade and become porous, allowing enzyme-containing cytoplasm to escape. The degradation of bodily tissues following death is called putrefaction. The normal course of events once rigor mortis disappears is putrefaction. A greenish discolouration of the skin over the caecum region is typically the first external sign of putrefaction in a cadaver resting in the air. In summer, it occurs within 12–18 hours, and in winter, it appears in 01-02 days ^[4].

To help Investigating Officers (IO) with death investigations by limiting the duration of the investigation and so assisting in the reduction of the number of suspects in homicide cases, forensic pathologists are fundamentally required to estimate the time since death (TSD). Hence present study aims to estimate the time since death from rigor mortis, postmortem staining and decomposition in this region of our state.










MATERIALS AND METHODS

Research Design- The Mortuary Prospective cross-sectional study was conducted among all deceased autopsied at the Mortuary of the Department of Forensic Medicine and Toxicology, AGMC & GBP Hospital for three months (April-June 2024, Summer season) fulfilling the inclusion and exclusion criteria during the study period. This study focused on shaping the time since death (TSD) by examining postmortem variations which

include rigor mortis, postmortem staining, and decomposition. To conduct this research, it was included around 94 samples among 277 cases conventional during the study period based on strict inclusion and exclusion criteria. In addition, this study focused on consecutive sampling which was used for data collection. The study depends on medico-legal autopsies, inquest reports, and clinical records, supplemented by data from relatives and examining officers. Consecutive sampling was done and a total of 277 cases were received in the hospital within 03 months. Out of 277 cases, 94 cases were selected i.e., April (31 cases), May (33 cases) and June (30 cases) (Fig. 1) respectively based on eligibility criteria.

Inclusion Criteria- All confirmed hospital death cases.

Exclusion Criteria

-  Death outside hospital
-  Dead bodies with musculoskeletal deformities
-  If deceased had a history of chronic illness
-  Body kept in the cold chamber
-  Body with advanced stage of decomposition
-  Burn cases
-  Foetus
-  Poisoning
-  Heat stroke cases, 10. Dead bodies having emaciated built.

Statistical Analysis- Data gathered was entered in a Microsoft Excel sheet. Descriptive and inferential statistics were performed accordingly by using IBM SPSS (Statistical Package for Social Science) Statistics for Windows, version 25 (IBM Corp., Armonk, NY). A *P*-value of less than 0.05 was used to indicate significant results.

Ethical Clearance- A prior approval was obtained from the Institutional Ethical Committee.

RESULTS

The data was collected from (a) Medico-legal autopsies conducted at the Mortuary of AGMC & GBP Hospital, (b) Medico-legal case register, inquest reports, Hospital bed tickets, (c) History from relatives, and friends of the deceased and statements from Investigating Police Officer. Consent for collecting the required data was taken from legally authorized persons. A predesigned proforma was used to record the relevant information and autopsy findings (Fig. 1).

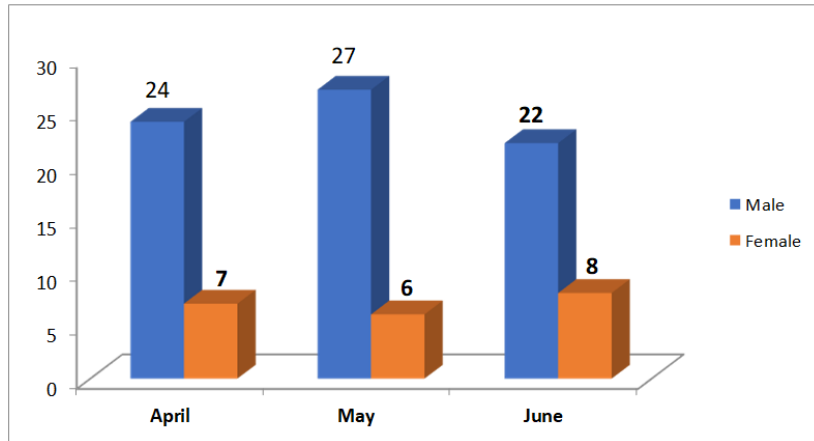


Fig. 1: Number of cases received per month

In the present study, the mean age of patients was 43.21 ± 3.5 years. The total number of males was 73 (77.66%) and females was 21 (22.34%) as shown in Fig. 2.

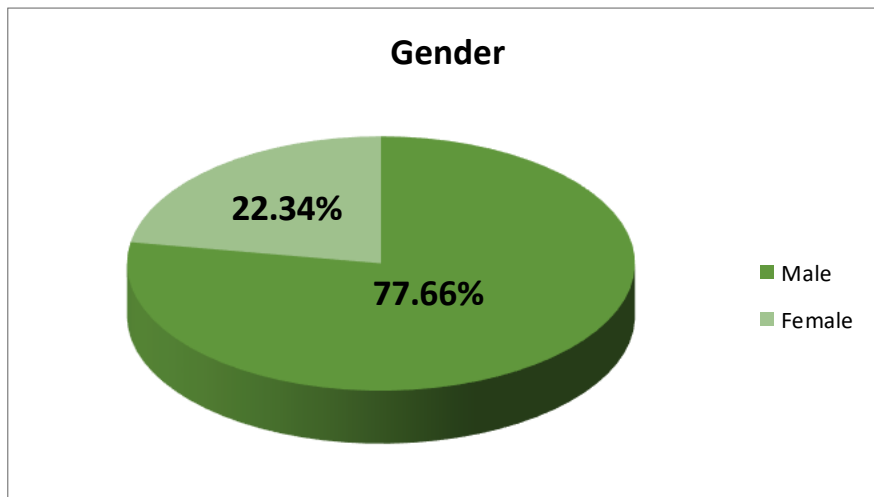


Fig. 2: Distribution of gender

The most common cause of death was head injury (38.3%), followed by shock & hemorrhage due to multiple injuries (23.4%), asphyxia due to hanging (18.1%), myocardial infarction (9.5%), pancreatitis (6.4%), electrocution (3.2%) and firearm injury (1.1%) as shown in Fig. 3.

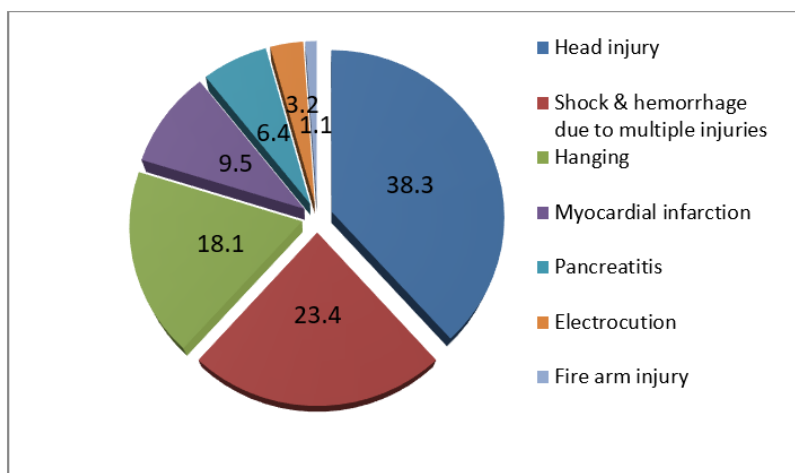


Fig. 3: Distribution of cases based on cause of death

Post-mortem staining was well developed but not fixed in the cases studied three to six hours after death. It was

well developed and fixed in every case that was studied between six and forty-eight hours as shown in Table 1.

Table 1: Status of post-mortem staining at different time intervals

TSD (hrs)	PMS not developed	PMS well develop but not fixed	PMS fully developed and fixed	Total (94)
3 to 6	0	26	0	26 (27.6%)
6.01 to 12	0	0	30	30 (31.9%)
12.01 to 18	0	0	16	16 (17.0%)
18.01 to 24	0	0	15	15 (15.9%)
24.01 to 36	0	0	5	5 (5.4%)
>36	0	0	2	2 (2.2%)

In the current set of cases, it was observed that rigor mortis was a crucial finding that allowed for the prudent calculation of the amount of time that had passed since death. Rigor mortis was present in nearly every case that was investigated between three and twenty-four hours

after the patient passed away. When the cases were assessed 24.01 to 36 hours after the death, in 5.4% of the cases, rigor mortis had started passing away from the body and beyond 36.01 hours, it had passed away after the patient's death as shown in Table 2.

Table 2: Status of rigor mortis in different time intervals

TSD (hrs)	Not developed	Developing	Well developed	Passing away	Passes away	Total(94)
3 to 6	0	26	0	0	0	26(27.6%)
6.01 to 12	0	0	30	0	0	30(31.9%)
12.01 to 18	0	0	16	0	0	16(17.0%)
18.01 to 24	0	0	15	0	0	15(15.9%)
24.01 to 36	0	0	0	5	0	5(5.4%)
>36	0	0	0	0	2	2(2.2%)

Decomposition manifests as a greenish discolouration in the right iliac fossa beyond 18 hours of death in 20.21% of cases. Overall, no hue shift was discovered in any of the cases that were looked at before 18 hours following

death. In 13.8% of patients, greenish discolouration of the iliac fossae was found between 18 to 24 hours after death. In all cases, the entire body turned greenish black within 36 hours in Table 3.

Table 3: Status of Decomposition in different post-mortem interval

TSD (hrs)	Decomposition		Total (94)
	Appeared	Not appeared	
3 to 6	0	26	–
6.01 to 12	0	30	–
12.01 to 18	0	16	–
18.01 to 24	13	2	13(13.8%)
24.01 to 36	4	1	4(4.3%)
>36	2	0	2(2.2%)

DISCUSSION

Estimating the postmortem interval is a crucial part of any medico-legal case and is crucial in circumstances involving unnatural deaths, such as homicides, accidents, and suicides. Several techniques have been employed to determine the precise moment of death. These encompass the examination of physical, chemical, biochemical, histological, and enzymatic alterations that occur gradually in the body of the deceased [5,6].

Since ancient times, the trio of Algor mortis, Rigor mortis, and Livor mortis have been used together to determine the period since death. Until yet, it remains a crucial and captivating factor for determining the postmortem interval [7]. Currently, two noble techniques, namely post-mortem staining and decomposition changes, are being used to determine the time since death. Hence the present study was done to estimate the time since death from rigor mortis, postmortem staining and decomposition.

In this study, the process of post-mortem staining was seen to be well-developed within a time frame of 03 to 06 hours after death. However, it becomes fixed and does not change significantly between 6.01 to 12 hours after death. According to Camps (1976), lividity becomes visible after 0.5 hours and is noticeable between 6 and 10 hours [8]. Polson *et al.* [9] established that lividity manifests as patchy mottled discoloration within 0.5 to 02 hours, which then expands to create widespread discoloration within 06-12 hours. According to Di Maio, lividity is typically noticeable within 0.5 to 02 hours after death. It gradually reaches its maximum hue after 08-12 hours. Fixation of postmortem lividity might occur before the 08–12-hour mark [10]. The results of this study are mostly consistent with the conclusions stated before and those of other researchers.

In this study, it was observed that Rigor mortis appeared in the entire body within a time frame of 03 to 24 hours after death. During the 24.01 to 36 hours following death, rigor mortis was observed in a passing away stage throughout the entire body in only 5.4% of the instances analyzed. However, after 36 hours, rigor mortis had passed off from the entire body in 100% of the cases. A study undertaken by Gorea RK from Amritsar involved the selection of 128 cases from different medicolegal cases brought to the mortuary complex of the medical college in Amritsar. In this study, the postmortem interval (PMI) is considered to be less than 03 hours and

15 minutes if rigor mortis has not yet appeared. The greatest period seen for incomplete rigor mortis in the cadaver is 14 hours. The phenomenon of rigor mortis provides us with a reliable post-mortem interval estimation provided proper consideration is given to the factors of temperature and humidity [11].

A comparable investigation was carried out by Sugatha M and colleagues. This study was a cross-sectional study conducted at Osmania General Hospital mortuary. It involved 500 medicolegal autopsies where the exact time of death was known and the bodies were stored at the ambient room temperature. The impact of several conditions on the onset and resolution of rigor mortis, such as temperature, humidity, and clothing, was also examined. The observations yielded nearly identical outcomes [12].

In the present study, 20.2% of cases showed greenish discoloration in the right iliac fossa within 18.01–24 hours of death due to decomposition. None of the cases examined before 18 hours after death showed a hue alteration. All bodies turned greenish-black in 36 hours. In these cases, the police prepared the inquest paper after 36 hours due to some technical issues like delay in identification, delayed arrival of the relatives, etc. The rate was 13.8% between 18 and 24 hours after death. It was identified within 24–36 hours after death in 4.3% of cases. It was detected in every case examined in the last three to five days. Experimental investigations by University of Tennessee students and professors examined natural deterioration in adult males and females of the three major races. Homicide victims, donated bodies, and unidentified bodies were among the 150 decaying bodies studied. Results showed that the rate of body decomposition is quite variable. General observations suggest that the variables that most influence the rate of human bodily decay are temperature, humidity, access by insects and other animals and burial depth. Although several known variables affect decomposition, many variables have yet to be defined [13].

CONCLUSIONS

The current study highlights the importance of rigor mortis, postmortem staining, and decomposition changes as key indicators for accurately estimating the time since death. These processes provide valuable forensic insights into the postmortem interval and

circumstances of death. Meticulous documentation of these factors is essential in all medico-legal cases to ensure accurate and reliable investigations.

The future prospects of this study lie in improving the accuracy of time-since-death estimations through advancements in forensic technology and methodologies. Incorporating biochemical markers, molecular techniques, and artificial intelligence could enhance the precision of analyzing rigor mortis, postmortem staining, and decomposition changes.

CONTRIBUTION OF AUTHORS

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Research design- Dr(s). Nirban Das, Jayanta Sankar Chakraborty, Pradipta Narayan Chakraborty

Supervision- Dr(s). Jayanta Sankar Chakraborty

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