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Original Article

Effect of Temperature and Humidity on Rigor Mortis: A Retrospective Medicolegal Study

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ABSTRACT

Rigor mortis is considered to be one of the early signs of death. Rigor mortis or post-mortem stiffening is a physico-chemical process involving both voluntary and involuntary muscles of the body. Though it is a reliable tool of estimating post-mortem interval, its onset, development and disappearance is affected by many external and internal factors. Temperature and humidity of the place from where body is recovered or where it remains after death plays an important role in the development of rigor mortis, which further affects the estimation of post-mortem interval.

Keywords: Rigor mortis, Stiffening, Temperature, Humidity, Post-mortem Interval, Estimation, Amritar

INTRODUCTION

Death is a process whereby life ceases to exist. Two phases of death have been recognised, namely death of the body, which is referred to as somatic death, and molecular death, which includes progressive disintegration of body tissues. Following death muscles of the body pass through three phases. The first stage is that of primary flaccidity, which occurs immediately after somatic death. The second stage is the development of rigidity known as rigor mortis. Secondary flaccidity or stage of resolution is the third stage when rigor mortis passes away[1]. Signs of cellular death are most vital to come to conclusion of time since death. Rigor mortis is one such important sign, whose presence and extent or absence can help time the post-mortem interval. Determination of time since death is very important in all cases of natural and unnatural deaths. Though it is of prime importance in criminal cases, it is also very important in all cases of deaths, which have taken place without knowledge of an authentic source. Doctors certifying death, insurance agencies, death registration office all needs to know exact or approximate time of death. Rigor mortis commences under average conditions within 3–4 h after death and disappears at 36–48 h after death. However the exact period and duration is highly variable. Estimating the time of death from rigor mortis is notoriously one of the most difficult and inaccurate technique in forensic pathology. Work on the onset, duration and disappearance of stiffening in various muscles after the stage of primary relaxation in a dead body has been extensively carried out both in India and abroad by various workers. These workers have shown that the onset and duration of rigor mortis depends on many factors including weather. Hence, a uniform time of appearance and disappearance of rigor mortis cannot be made applicable throughout a vast country as India, where different weather conditions exist throughout its various parts at a given time. Amritsar is one such a place in India that experiences extremes of weather conditions. The literature on the subjects in this region of the country is scanty. The present study was undertaken to study the effect of temperature, humidity and other factors on the

onset, duration and sequence of appearance and disappearance of rigor mortis in subjects of Amritsar region.

AIMS AND OBJECTIVES

1. To establish rigor mortis as an effective parameter to estimate post-mortem interval.
2. To study the effect of temperature and humidity on the onset, development and disappearance of rigor mortis.

MATERIAL AND METHODS

Five hundred medicolegal autopsies were selected where the exact time of death was known and the body had been kept at prevailing room temperature. To observe the effect of atmospheric and seasonal conditions, the period of study was divided into four groups corresponding to four seasons. A good-quality digital hygrometer was used to note the daily readings of temperature and humidity. The presence or absence of rigor mortis and its extent was noticed in both voluntary and involuntary muscles. In the joints, appearance and disappearance of rigor mortis were noted by seeing their movement for resistance offered.

Observations

In the present study, 78.4% cases studied were males and 21.6% subjects were females. 56.2% victims belonged to rural area as compared to 43.6% urbanites while residence of 0.2% males was unknown.

The alleged cause of death in 42.6% cases was road traffic accident, 11.6% deaths were due to poisoning, 9.2% victims had died due to natural disease and 9% due to burns. Railway accidents formed 6.8% of the share and miscellaneous other causes contributed 20.8% (Table 1).

Table 1: Cause of deathwise distribution of cases

Cause of death	No. of cases	Percentage (%)
Burns	45	9.0
Natural disease	46	9.2
Others	104	20.8
Poisoning	58	11.6
Railway accidents	34	6.8
Road side accidents	213	42.6
Total	**500**	**100.0**

66.2% cases were observed in 21–50 years of age group in which rigor mortis lasted longer as compared to 0–20 years (12%) and >50 years (17.8%) (Table 2).

Effect of Temperature and Humidity

In the months of April to June, fully developed rigor mortis lasted from 11 h 25 min to 28 h 25 min while in the quarter of July to September, complete rigor mortis lasted from 17 h 15 min to 34 h 20 min. The maximum temperature during these months ranged from 46.5°C to 26.6°C, while minimum temperature ranged between 27.6°C and 12°C. Relative humidity levels in these months varied between 95% and 31% as shown in Figure 1.

In the months of October to December, fully developed rigor mortis lasted from 16 hours 25 minutes to 61 hours 5 minutes while from January to March it lasted from 19 h 5 min to 50 h 15 min. The maximum temperature during these months ranged from 35.4 to 13.6 while minimum temperature ranged between 20C and -2.6°C and the relative humidity varied between 97% and 65% (Figure 1).

Time of Appearance and Disappearance

In the present study, it was observed that the average duration of onset of rigor mortis was 8 h and 39 min. The maximum duration in which rigor mortis had begun to appear in the body was 1 h and 35 min while the longest

Table 2: Relation of age with duration

Age group	No. of cases	Percentage (%)	Average duration		
			Onset	Complete	Disappearing
0–20	60	12.0	6 h 1 min	19 h 26 min	29 h 11 min
21–50	331	66.2	7 h 22 min	17 h 5 min	31 h 3 min
>50	89	17.8	7 h 56 min	16 h 52 min	29 h 11 min
Not mentioned	20	4.0	8 h 6 min	18 h 13 min	–
Total	**500**	**100.0**			

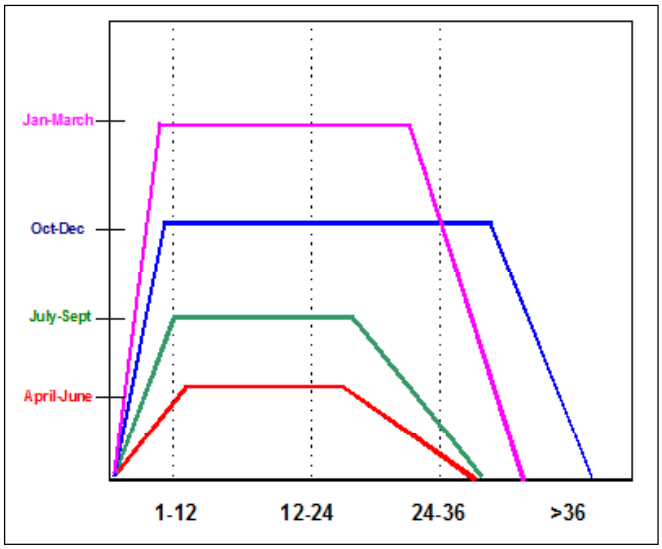

Figure 1: Average onset duration and disappearance of rigor mortis

duration by which rigor mortis had not completely appeared in the body was 24 h. The average duration for fully developed rigor mortis was 18 h and 19 min, the shortest duration being 3 h and 15 min while the longest duration was 33 h and 40 min. The average duration for disappearance of rigor mortis was 34 h and 36 min. The shortest duration by which rigor mortis had disappeared was 15 h and 30 min while one case was observed in which rigor mortis was present in some parts of the body at 70 h and 35 min as shown in Figure 1.

Site of Recovery

In cases recovered from open environment such as fields or roads, the average duration of onset of rigor mortis was early (6 h and 56 min) and average duration of disappearance was also early (24 h 44 min) as compared to dead bodies recovered from closed environment such as houses and hospitals (Table 3).

Clothing

The average duration of onset of rigor mortis (6 h 50 min) and disappearance of rigor mortis (27 h 17 min) was earlier in naked dead bodies as compared to clothed victims (Table 4).

DISCUSSION

Modi and Reddy observed that rigor mortis commenced in 1–2 h after death[2,3]. Contrary to the observations of these workers, Parikh was of the view that rigor mortis commenced in 2–3 h after death but had not, commented anything about weather conditions[4]. The findings of present study are consistent with the observations of Dhattarwal *et al*. regarding duration who found that average duration is more in winters and less in summers[5].

As regards sequence of appearance and disappearance of rigor mortis, the present study is in agreement with the observations of Dhattarwal according to whom rigor mortis first appears in eyelids, followed by lower jaw,

Table 3: Site of recovery wise distribution of cases

Type of environment	No. of cases	Percentage (%)	Average duration		
			Onset	Complete	Disappearing
Open					
Field	20	4.00	6 h 56 min	19 h 8 min	25 h 44 min
Road side	143	28.60			
Railway track	31	6.20			
Closed					
House	79	15.80	7 h 22 min	17 h 21 min	34 h 8 min
Hospital	227	45.40			
Total	**500**	**100.00**			

Table 4: Relation with clothing

Clothing	No. of cases	Percentage (%)	Average duration		
			Onset	Complete	Disappearing
Naked	24	4.8	6 h 50 min	18 h 9 min	27 h 17 min
Clothed	476	95.2	7 h 20 min	17 h 20 min	30 h 15 min
Total	**500**	**100.0**			

neck, upper limbs, trunk, lower limbs and lastly in fingers as toes. It disappears in the same order.

Observations of early appearance and disappearance of rigor mortis in young and older subjects in comparison to adults are consistent with findings of others[2,3,5,6].

According to other workers, bodies of those who die from debilitating diseases pass rapidly into a state of rigidity, which is of short duration. In the present study though rigor mortis appeared early, it disappeared late in such cases[1,2,7,8].

According to Glaister, stronger muscular the person is at the time of death, the later is the time of onset and shorter the duration. It was noticed in the present study that in well-built individuals' rigor mortis appeared early and lasted for a lesser time[8].

CONCLUSION

In the hot weather from April to September, the average duration of onset was 8 h 8 min. Complete rigor mortis lasted for an average duration of 18 h 2 min and average duration for disappearance of rigor mortis during these months was 30 h. In the winter months of October to March, the average duration of onset of rigor mortis was 7 h 25 min. Fully developed rigor mortis lasted for 19 h and 15 min and it disappeared at an average duration of 36 h and 8 min. So from the above-mentioned observations we can conclude that the usually taught standard rule of twelve does not hold true in every case as the process of rigor mortis is influenced by many variable especially temperature and humidity. In a country such as India, with wide variations of weather, each and every state needs to have its own time table of rigor mortis so that it proves to be an effective tool for measuring post-mortem interval.

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