

## Estimation of Time Since Death by Potassium ion Level in the Vitreous Fluids: A Postmortem Study in a Tertiary Care Center, South India

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### Abstract

**Background:** It is of great value to find time since death in the medicolegal investigations like serious crimes. Vitreous humor was more often used for the biochemical analysis as it is less contaminated or not affected by the putrefactive changes than other fluids of the body. It was stated by many researchers that potassium levels in the vitreous humour is more accurate in predicting time since death.

**Aim:** The aim of the study is to assess the time since death using potassium level in the vitreous humor

**Methodology:** This study includes 54 cases of victims brought to the tertiary care hospital based on inclusion and exclusion criteria. Cases with known time of death and with clear vitreous humor samples were included. Baseline characteristics like name, age, gender, exact time since death was collected. Vitreous humor was collected through appropriate standardized technique. Sampling time was also noted. The collected data was entered in MS excel and analysis done in SPSS 23 software. P value <0.05 is considered to be significant.

**Results:** Majority of the study participants belongs to 57-67 years of age group (28%) followed by 27-37 years of age (22%). Male predominance was observed in our study 41(76%). There is a linear correlation found between the vitreous potassium concentration and the postmortem interval ( $R^2=0.907$ ). The rate of the vitreous potassium increase was 0.36 meq/hr (Coefficient of regression =2.76 meq/1/hr)

**Conclusion:** There is a linear relationship found between vitreous potassium concentration and time since death. Thus potassium in the vitreous can be used for assessing the time since death.

**Keywords:** Postmortem interval, vitreous humor, time since death, medicolegal.

### Introduction

The interval between the death and the time of postmortem examination is known as Time since

death. Immediately after death or shortly many changes occur after death but each have their own time and rate<sup>1</sup>. Time since death plays a major role

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in the crime investigations. Time since death is determined with the help of Vitreous humor fluid as it is not affected by the degradation and contamination due to postmortem<sup>2</sup>.

Forensic pathology uses vitreous humor as it has postmortem stability. Many studies have been in process in studying the biochemical changes which occurs in the body fluids of the diseased persons like aqueous humor, vitreous humor, cerebrospinal fluid and blood. It has been found that electrolyte changes occur in these fluids related to the postmortem time. Of these vitreous humor is the most commonly used fluid in estimating the time since death. Though there are many contents in the vitreous humor, potassium is considered as the major determinant<sup>3</sup>.

Potassium is actively transported from the ciliary body into the posterior chamber. Anterior chamber and lens also contributes potassium level<sup>4</sup>. The normal potassium level in the vitreous is 3.8 mmol. Soon after death the potassium is leaked from the retinal cells which is due to the non operating Na<sup>+</sup>K<sup>+</sup> pump. This leads to the increase of potassium in the postmortem. This increase depends on the environmental condition<sup>5</sup>. Thus this study was done to assess the time since death using potassium level in the vitreous humor.

## Methodology

### Study setting:

Hospital based cross sectional study was conducted in the Department of Forensic Medicine, Government Medical College, Thrissur which is a tertiary care centre. The study was done for a period of one year, from August 2017 to July 2018.

### Inclusion criteria:

- Cases with known time of death
- Cases with clear vitreous humor samples

### Exclusion criteria:

- Visibly discolored sample was excluded from the study
- Bodies with damaged eye balls
- Cases where the exact time of death was not known

### Sample Size:

Based on the inclusion and exclusion criteria the

victims were recruited for our study. The final sample size attained during the study period is 54.

### Data collection:

Personal particulars like Name, Age, Gender, exact time of death were collected. Survival period was calculated from the treatment findings and the autopsy findings. The sampling time was also collected.

### Vitreous humor collection:

After obtaining the consent, vitreous humor was collected from the posterior chamber of eye, slowly and gradually in such a way avoiding tearing of loose fragment of tissue. The puncture of 5-6 mm away from the limbus was made using a sterile 5 ml syringe and needle of size 22 gauge. From one eye of the diseased 1 ml of the vitreous was collected in the rubber stoppered vial. In order to maintain the shape of the eyeball normal saline was injected into that eye. Then the sample was sent for the biochemical analysis lab. Samples were centrifuged for 10 minutes at 4000 rpm. Then it was analyzed by MEDICA EASLYTE Na<sup>+</sup>/K<sup>+</sup> Automated analyzer concentration of potassium was recorded.

### Statistical analysis:

After collecting the data, it was entered in MS excel Windows 10. Statistical analysis was done in SPSS 23. Continuous data were expressed in terms of Mean  $\pm$  Standard deviation and. Categorical variable were expressed in terms of numbers (percentages). P value of <0.05 is considered as significant

## Results

**Table 1: Age and sex of the study participants**

Variables	Number(N)	Percentages (%)
<b>Age category</b>		
< 27	8	15%
27 -37	12	22%
37-47	7	13%
47-57	5	9%
57-67	15	28%
>67	7	13%
<b>Sex</b>		
Male	41	76%
Female	13	24%

Majority of the study participants were in 57-67 years of age 15(28%) followed by 27-37 years of age 12(22%). Male preponderance were observed in the study 41(76%).

**Table 2: Distribution of cases based on time since death**

S. No	TSD (hrs)	No. of cases	% of cases
1	Within 8	6	11%
2	08 - 13	6	11%
3	13 - 18	14	26%
4	18 - 23	11	20%
5	23 - 28	10	19%
6	28 - 32	5	9%
7	Above 32	2	4%
Total		54	100%

It is concluded from table 2 that the majority number of cases were in 13-18 TSD was 14(26%) followed by 18-23 hours TSD 11(20%). Only 2(4%) of the cases were observed in >32 hrs.

**Table 3: PMI (hrs.)**

TSD(hr)	Frequency	Mean of PMI (hrs)	SD of PMI (hrs)	Range of PMI (hrs)
03 - 08	6	5.16	1.40	3.7
08 - 13	6	10.56	1.96	4.0
13 - 18	14	14.96	1.34	4.4
18 - 23	11	19.79	1.09	3.3
23 - 28	10	23.53	0.88	3.0
28 - 32	5	26.94	0.72	1.9
32 - 37	2	33.18	1.38	2.0

**Table 4: Levels of Potassium (range and mean) depending upon the time since death (TSD)**

TSD(hr)	Frequency	Mean of K+(mEq/L)	SD of K+(mEq/L)	Range of K+(mEq/L)
03 - 08	6	6.61	0.70	1.8
08 - 13	6	7.50	0.33	0.7
13 - 18	14	8.43	0.67	2.2
18 - 23	11	10.45	1.06	3.7
23 - 28	10	11.41	1.25	4.1
28 - 32	5	13.69	2.30	5.6
32 - 37	2	12.74	5.07	7.2

Out of the estimated concentration in the vitreous humor samples collected from 54 subjects the minimum value for vitreous potassium concentration

was 5.89mEq/L and the maximum value was 16.32mEq/L (Mean  $\pm$  SD, 9.74  $\pm$  2.47).

**Table 5: Comparison of potassium & PMI using student t-test**

S.No	PMI (hrs)	No.of cases	Mean (K+)	SD (K+)	Range (K+)	t-value	P-value
1	Within 12	12	7.05166667	0.665668	1.93	-8.34	<0.05
2	12 to 24	34	9.84441176	1.540415	5.67	-6.54	<0.05
3	Above 24	8	13.30375	2.471411	7.17	-3.56	<0.05

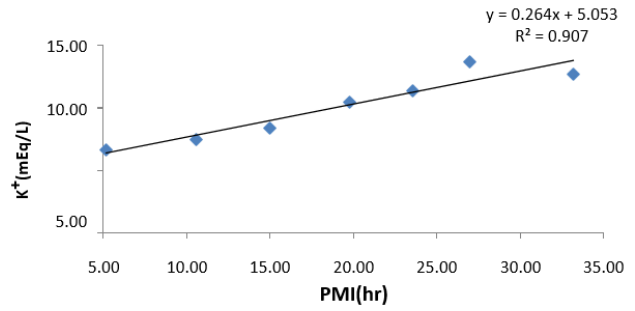
Comparing 1&2, 1&3, 2&3 the p value were highly significant

From the above statistical analysis it is evident

that there is highly significant increase in the potassium concentration with the increasing time since death.

**Table 6: Correlation between postmortem interval and vitreous humor potassium for proposed formulae**

Mean of PMI(hr)	Mean of K+(mEq/L)
5.16	6.61
10.56	7.50
14.96	8.43
19.79	10.45
23.53	11.41
26.94	13.69
33.18	12.74



**Fig 1: Scatter diagram showing correlation between Time Since Death and Vitreous potassium concentration**

The linear regression correlation of vitreous potassium and PMI was found to be strongly correlated and highly significant.(  $R^2=0.907$  )

**Table 7: Comparison of potassium concentration according to different age groups**

Age groups	No. of cases	Mean K+(mEq/L)	SD K+(mEq/L)	Range K+(mEq/L)	P value
Within 27	8	10.21	2.95	9.33	>0.05
27 to 37	12	117.41	2.64	9.33	>0.05
37 to 47	7	65.35	2.20	5.31	>0.05
47 to 57	5	44.33	1.34	3.87	>0.05
57 to 67	15	158.10	2.28	7.90	>0.05
Above 67	7	58.86	1.70	5.33	>0.05

From the above statistical analysis, it is evident that there is no significant effect of age on the levels of Potassium up to 57 years of age. But above 57 years of age, there is significance.

**Discussion**

In our study out of the 54 cases were included 41(76%) were males followed by females 13(24%). Most of our study participants were 57-67 years 15(28%) followed by 27-37 years 12(22%). This was in contrast to the Dr Amit Srivastava et al<sup>6</sup> study most of the study participants were in the age group of 20-40 years. Males preponderance was also seen in his study 127(63.5%). In our study majority of the study participants fall in range of <24 hours of study 37(69%). Similar results were also seen in the Dr Amit Srivastava et al study<sup>6</sup>.

It was proposed by many studies that retinal cells and the vascular choroid are the source of the potassium influx in the vitreous humour<sup>7,8,9,10</sup>.

Naumann et al<sup>11</sup> also in his study stated that due to the autolysis in the cell membrane the potassium has been influxed. Breakdown of the metabolic especially anaerobic active membrane transport stops and selective membrane permeability was lost and thus facilitating the diffusion of ions due to concentration gradient was the finding of the study done by Madea et al<sup>12</sup>.

In our study we found that there is a linear relation of increase in the potassium ions level in vitreous with postmortem interval .The linear regression correlation of vitreous potassium and PMI was found to be strongly correlated and highly significant. (  $R^2=0.907$  ).This finding was also seen in other studies done by Amit Srivastava et al<sup>6</sup>, Dr. Priyanka vaitla et al<sup>13</sup>, Ahi et al<sup>14</sup>, Jashnani et al<sup>15</sup>.

In our study age have an influence on the potassium levels in the vitreous humour. Similar result was also reported by Dr. Priyankavaitla et al<sup>13</sup>and Jashnani et al<sup>15</sup>

**Limitation:**

The main limitation of the study is its low sample size. Secondly we didn't measure the serum electrolytes concentration at time of death as it may interfere with our study results

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**Conclusion**

It is concluded in our study that a linear relationship was found between the vitreous potassium concentration and time since death. Our method used in our study is extremely simple as it requires only inexpensive apparatus for the collection of sample and processing. Thus vitreous potassium is a very useful indication for determining the time since death.

**Recommendations:**

It is recommended to do a study which sees correlation with electrolyte concentration of the serum at the time of death. And we have only little data published in the vitreous potassium and its relationship with the postmortem interval. More number of studies have to be done to throw light in that grey area.

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