# Role of Vitreous Potassium Level In Estimating Postmortem Interval And The Factors Affecting It

Rajinderjit Singh Ahi and Vishal Garg


## ABSTRACT

**Aim:** The present study was conducted to assess the level of potassium in the vitreous fluid, to calculate the post mortem interval from it and to study the effects of environmental factors like temperature and humidity on it. **Material and Methods:** 176 cases were included in the study. The vitreous fluid was taken from the left eye just before the commencement of autopsy and was assessed for potassium level. The potassium level was determined by flame photometry method. The post mortem interval (PMI) was then calculated by applying the Sturner equation. **Result:** Level of potassium in vitreous was found to be increased significantly with increase in PMI. It was found that the vitreous humour potassium concentration was increasing in a linear fashion with increasing time since death (TSD) and this increase in the level was independent of the factors like environmental temperature and humidity. **Conclusion:** Potassium level in the vitreous fluid increases significantly with increase in PMI and the environmental factors like temperature and humidity has no significant effect on the potassium levels in vitreous fluid.


**Key Words:** Potassium, time since death, post mortem interval, vitreous fluid

## INTRODUCTION

No problem in forensic medicine has been investigated as thoroughly as that of determining the TSD on the basis of post mortem findings. Many chemical changes begin to take place in the body immediately or shortly after death and progress in a fairly orderly fashion until the body disintegrates. Each change has its own time factor or rate. These changes occur in various body fluids viz blood, spinal fluid and vitreous humor of eye. Thus determination of the chemical abnormalities could help forensic pathologists to ascertain time since death more precisely [1].

For investigations of crime, it is very important to determine 'time since death' that is the interval between death and the time of postmortem examination also called as 'postmortem interval'. It provides a clue to the investigating officer to institute suitable enquiries to apprehend the persons likely to be responsible for the crime and to eliminate the innocent ones [2]. In civil cases also the matter concerning transfer of estate or property may depend upon the time of death [3].

The time of death is sometimes extremely important. It is a question almost invariably asked by police officers, sometimes with a touching faith in the accuracy of the estimate. But determination of accurate time of death is extremely difficult as timings of onset and the rates of postmortem changes are usually governed by unpredictable endogenous and exogenous factors [3].

Various body fluids which are available for the chemical examination are whole blood, serum, cerebrospinal fluid (CSF), aqueous humor and vitreous humor. Amongst these the most widely used method is estimation of vitreous humor potassium concentration [4]. Other determinations that may prove valuable include the potassium content of the aqueous humor and lactic acid, ascorbic acid, non protein nitrogen, sodium and chloride [5] and magnesium, phosphate and bicarbonate [6] content of the vitreous humor.

Vitreous humor of eye is relatively stable, less susceptible than other body fluids to rapid chemical changes and contamination, easily accessible and its composition is quite similar to that of aqueous fluid, cerebrospinal fluid and serum; thus it is suitable for many analyses to estimate PMI [7]. The normal potassium level in the vitreous humor is about 3.8 mmol/l. There is active transport of potassium from ciliary body into the posterior chamber and anterior chamber; the lens may also contribute to vitreous levels of potassium [8].

The accurate prediction of time of death is of great value in medico legal investigations of serious crimes, thus as a result several workers have reported the possibility of accurate prediction of TSD (within two hours), from measurement of the levels of potassium in the vitreous humor [9]. The single most accurate method to determine PMI is the potassium content of the vitreous humor, which shows a linear rise with in the time interval of 12-100 hours after death. The rate of vitreous potassium rise is fairly independent of environmental influence [10]. The objective of the study was to assess the level of potassium in vitreous fluid with increasing TSD and to study the effect of temperature and humidity on it.

## MATERIAL AND METHODS

One hundred seventy six cases brought to the mortuary formed the material for collection of vitreous humor. The information regarding time of death was gathered from police records, hospital records and from eye witnesses, relatives, friends and attendants of the deceased. Cases where exact time of death was not known were not included in this series.

Environmental temperature and humidity were recorded at the time of collecting samples.

The sample was drawn from the left eye at the time of commencement of autopsy. Only the clear samples were taken, samples having any particulate matter or blood were discarded and were not included in the study. All the information about the deceased i.e. age, sex, address, cause of death, exact time of death, time of each sampling, temperature, humidity and corresponding potassium concentrations were fully recorded in the performa.

Vitreous humor was collected at autopsy from the posterior chamber of eye, slowly and gradually avoiding tearing of loose fragment of

tissues by needle aspiration through a puncture made 5-6 mm away from the limbus using 10 ml sterile syringe and 20 gauge needle and was poured in a rubber stopper vial.

Each sample was centrifuged at 3000 r.p.m for 10 minutes and the supernatant fluid was used for determination of potassium by flame photometry and the values were expressed in mEq/l (mmol) [11].

## OBSERVATION

The present study was undertaken to correlate the time of death with the levels of potassium in the vitreous humor. One seventy six cases to the mortuary were selected for estimation of potassium in the vitreous humor of left eye. The cases were acute traumatic deaths and all hospital deaths brought to the mortuary. Only the clear vitreous humor was taken for the study and the samples having blood or any particulate matter were discarded.

| S. No. | TSD (hrs) | No. of cases | % of cases |
|---|---|---|---|
| 1. | Within 12 hrs | 48 | 27.27 % |
| 2. | 12.1 – 24 hrs | 105 | 59.65 % |
| 3. | Above 24 hrs | 23 | 13.06 % |
| | Total | 176 | 100 % |

**[Table/Fig 1]:** Percentage of cases on the basis of time since death (TSD)

| S No. | TSD (hrs) | No. of cases | Range $K^+$ (mEq/l) | Mean ± SD $K^+$ (mEq/l) |
|---|---|---|---|---|
| 1. | Within 12 hrs | 48 | 3.6-18.6 | 06.78 ± 2.11 |
| 2. | 12.1 – 24 hrs | 105 | 7.0-12.0 | 09.42 ± 1.14 |
| 3. | Above 24 hrs | 23 | 9.2-17.8 | 12.14 ± 1.98 |
| | **Total** | **176** | | |

Statistical Analysis

| Comparison | t value | p value | Significance |
|---|---|---|---|
| 1 & 2 | 10.00 | < 0.001 | HS |
| 1 & 3 | 10.19 | < 0.001 | HS |
| 2 & 3 | 08.88 | < 0.001 | HS |

**[Table/Fig 2]:** Levels of potassium (range and mean) on the basis of time since death (TSD)

| S No. | Humidity (%) | No. of cases | Range $K^+$ (mEq/l) | Mean ± SD $K^+$ (mEq/l) |
|---|---|---|---|---|
| 1. | 0-40 | 13 | 8.2-11.0 | 9.03 ± 0.90 |
| 2. | 41-60 | 7 | 8.0-10.6 | 8.74 ± 0.85 |
| 3. | 61-80 | 11 | 8.0-10.6 | 9.10 ± 1.01 |
| 4. | 81-100 | 17 | 8.2-10.5 | 9.13 ± 0.65 |

Statistical Analysis

| Comparison | t value | p value | Significance |
|---|---|---|---|
| 1 & 2 | 0.68 | > 0.05 | NS |
| 1 & 3 | 0.17 | > 0.05 | NS |
| 1 & 4 | 0.36 | > 0.05 | NS |
| 2 & 3 | 0.76 | > 0.05 | NS |
| 2 & 4 | 1.22 | > 0.05 | NS |
| 3 & 4 | 0.11 | > 0.05 | NS |

**[Table/Fig 3]:** Comparison of Potassium concentration according to the Humidity in cases having approximately same TSD

## RESULT

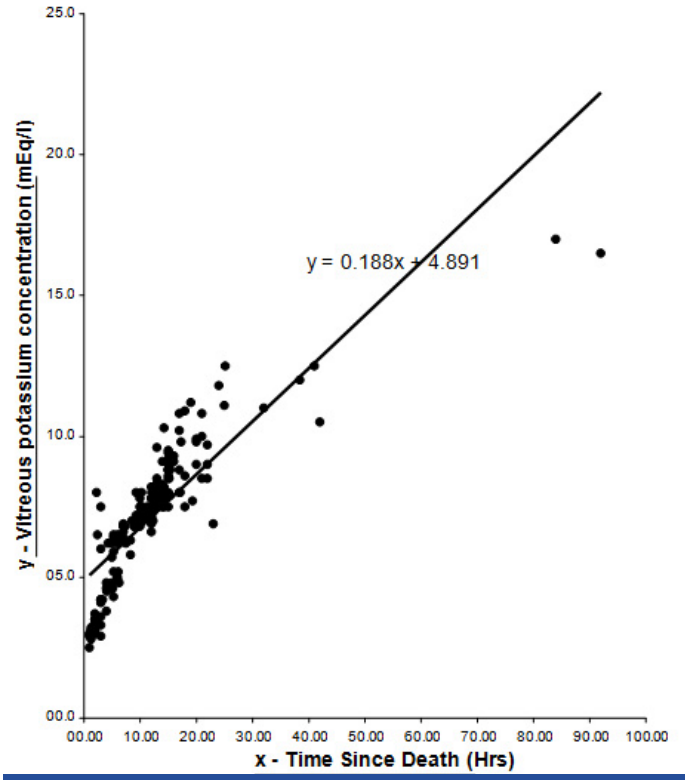
The present study was undertaken to correlate the time of death with the levels of potassium in the vitreous humor. One seventy six cases to the mortuary were selected for estimation of potassium in the vitreous humour of left eye. The cases were acute traumatic deaths and all hospital deaths brought to the mortuary.

| S No. | Temperature (0C) | No. of cases | Range $K^+$ (mEq/l) | Mean ± SD $K^+$ (mEq/l) |
|---|---|---|---|---|
| 1. | 21-25 | 16 | 8.0-10.2 | 8.68 ± 0.65 |
| 2. | 26-30 | 22 | 8.2-11.0 | 9.25 ± 0.90 |
| 3. | 31-35 | 9 | 8.3-10.5 | 9.22 ± 0.79 |
| 4. | 36-40 | 1 | – | 8.60 ± 0.00 |

Statistical Analysis

| Comparison | t value | P value | Significance |
|---|---|---|---|
| 1 & 2 | 2.13 | > 0.05 | NS |
| 1 & 3 | 1.84 | > 0.05 | NS |
| 1 & 4 | – | > 0.05 | NS |
| 2 & 3 | 0.08 | > 0.05 | NS |
| 2 & 4 | – | – | – |
| 3 & 4 | – | – | – |

**[Table/Fig 4]:** Comparison of Potassium concentration according to the Temperature in cases having approximately same TSD




**[Table/Fig 5]:** Scatter diagram showing correlation between Time Since Death and Vitreous Potassium concentration.

The experimental findings indicate that there was significant increase in the potassium concentration with increasing TSD [Table/Fig 2] and there is linear coorelation between them [Table/Fig 5]. Moreover, there was no significant effect of humidity [Table/Fig 3] or temperature within the range of 21-35°C [Table/Fig 4] on the level of potassium in the vitreous humour of the eye post mortem.

## DISCUSSION

Various body fluids are available for chemical examination. The vitreous humor is preferred in this type of investigation because it has larger volume, easily obtainable and is usually free of contamination. It is relatively inert and only slightly influenced by sudden fluctuations in the blood chemistry of the human body. Accurate estimation of PMI

(Postmortem interval) has great values to criminal investigation and trial. The levels of chemical components in human vitreous humor are changed with time after death, which can help estimate the PMI [12].

The present study shows that there is considerable rise in the levels of potassium in the vitreous humor with increasing PMI, which is supported by other studies [5, 13-16]. The rise in potassium level is due to the autolysis of the vascular choroids and retinal cells of the eye [14]. There was a linear increase in vitreous potassium level with rise of PMI. This indicates that rise in potassium levels after death has a strong correlation with the PMI [17].

Factors like age, sex, cause of death, season of death, and refrigeration of sample did not influence the vitreous humor potassium values [18]. Two important environmental factors that did not have any effect on the levels of potassium were humidity and temperature, which were in agreement with other studies [5],[6],[19-21]. In the present study it was observed that within the range of 21-40ºC there was no significant change in vitreous potassium level.

## CONCLUSION

The study of potassium in the vitreous humor shows that there is considerable rise in the levels of potassium with increasing PMI and this is one of the most accurate methods of estimating time of death. Humidity and the environmental temperature between 21-35ºC will not significantly change the vitreous potassium level. In the present study the sample from one eye (left eye) was taken which can be a limitation to some extent. We took the temperature of limited range (21-40ºC) although only a single post-mortem specimen was available for the upper range (36-40°C), which has very limited value both from a scientific and statistical viewpoint. These findings can be different from the other studies conducted to see the effect of extreme temperature on vitreous potassium level.

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**AUTHORS:**

1. Dr. Rajinderjit Singh Ahi: Assistant Professor, Department of Biochemistry, Adesh Institute of Medical Sciences and Research, Bathinda.
2. Dr. Vishal Garg: Assosciate Professor, Department of Forensic Medicine, Adesh Institute of Medical Sciences and Research, Bathinda.

**NAME, ADDRESS, TELEPHONE, E-MAIL ID OF THE CORRESPONDING AUTHOR:**

Dr. Rajinderjit Singh Ahi, Assistant Professor, Department of Biochemistry, Adesh Institute of Medical Sciences and Research, Bathinda. Mobile: 9914118349, E.mail: rajindersahi@yahoo.co.in



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