

Correlation between Vitreous Humor Potassium and Time Since Death

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Abstract: Objective: In Forensic medicine, estimation of time since death plays an important role. The present study was conducted to assess the level of potassium in vitreous humor and to determine the time since death.

Materials and methods: 50 cases brought to the mortuary at Osmania general hospital, Hyderabad formed the material for collection of vitreous humor. Information regarding time of death was gathered. Cases where exact time of death was not known were not included in the study. Analysis was done immediately after the vitreous humor was aspirated. Samples for vitreous humour potassium were analysed by Ion selective method. Cases were divided into five groups according to time since death and analysed statistically.

Results: The postmortem interval varied from 5.15 to 72.45hrs. Vitreous humor potassium levels were significantly increased ($p < 0.0001$) with increased time since death. There was a linear rise in potassium concentration with increasing time since death and this increase in the level was independent of the factors like age and sex.

Conclusion: There is a linear relationship between vitreous potassium and time since death. After death, the $Na^+ - K^+$ pump does not operate, therefore K^+ is leaked out of the retinal cells, leading to high postmortem levels of potassium. Therefore, Vitreous humor potassium levels can be a good method of determining time since death along with other traditional methods.

Keywords: Vitreous humor, Potassium, Time since death

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I. Introduction

Time since death i.e, the interval between death and the time of postmortem examination is very important in the investigation of crime. Many changes occur immediately or shortly after death and have their own time factor or rate[1]. Biochemical analysis of different body fluids has become a useful supplementary to the traditional signs of postmortem lividity and rigor mortis in the accurate prediction of time since death[2]. In this regard, in the recent times, estimation of potassium levels in vitreous humor has gained much attention. The vitreous humor is much less subjected to contamination or putrefactive changes than with blood, serum or CSF and is easily accessible[3]. There is active transport of potassium from ciliary body into the posterior chamber and anterior chamber and the lens may also contribute to the levels of potassium [4]. After death, the $Na^+ - K^+$ pump does not operate, therefore K^+ is leaked out of the retinal cells, leading to high postmortem levels of potassium. The rate of potassium rise is fairly independent of environmental influence [5]. The present study was conducted to assess the level of potassium in vitreous humor and to determine the time since death.

II. Materials and methods

50 cases brought to the Osmania general hospital mortuary were included in the study and formed the material for collection of vitreous humor. The information regarding time of death -gathered from police records, hospital records and from eye witnesses, relatives, friends and attendants of the deceased. Only those cases for which exact time of death was known were included in the study.

2.1 Inclusion criteria

- ⊙ Clear samples
- ⊙ Cases with known Time since death
- ⊙ Cases with known cause of death

2.2 Exclusion criteria

- ⊙ Samples having any particulate matter
- ⊙ Samples contaminated with blood

⊙ Cases with antemortem major metabolic disorders.

2.3 Collection of sample:

The sample was drawn from the left eye at the time of commencement of autopsy. Needle aspiration 5-6 mm away from the limbus using 10 ml sterile syringe and 20 gauge needle. Normal saline was injected for cosmetic restoration of the eyeball after aspiration of vitreous fluid. Analysis done immediately after aspiration of sample. Each sample was centrifuged at 3000 r.p.m for 10 minutes and the supernatant fluid was used for determination of potassium by ion selective electrode method.

2.4 Statistics

Linear regression analysis, ANOVA and Pearson correlation were used for statistical analysis using Graphpad prism 6.

III. Results

The postmortem interval varied from 5.15 to 72.45 hours. Table 1 shows range and mean values of potassium in different groups based on the time since death. The values of vitreous potassium and death interval were significantly correlated ($r = 0.848$). The intercept of the regression line on the y axis for the potassium scatter plot was 15.5 mEq/L. The slope of the regression line (or the rate of rise of concentration of potassium) calculated from the potassium data was 3.32 mEq/L/ hour. From these data the following equation was constructed –

$$\text{Death interval} = 3.32 \times \text{Potassium} - 15.52$$

Table 1: Levels of potassium (range and mean) on basis of time since death

S.NO	TSD(hrs)	No. of cases	Range K+ (mEq/L)	Mean ± SD K+ (mEq/L)
1	With in 12hrs	8	5.8 – 9.7	7.1 ± 1.2
2	12.1 – 24 hrs	18	8.0 – 17.0	11.6 ± 2.5
3	24.1 – 36 hrs	9	8.6 – 18.3	14.5 ± 2.8
4	36.1 – 48 hrs	8	14.0 – 17.6	15.9 ± 1.2
5	Above 48 hrs	7	18.4 – 20.0	19.3 ± 0.6

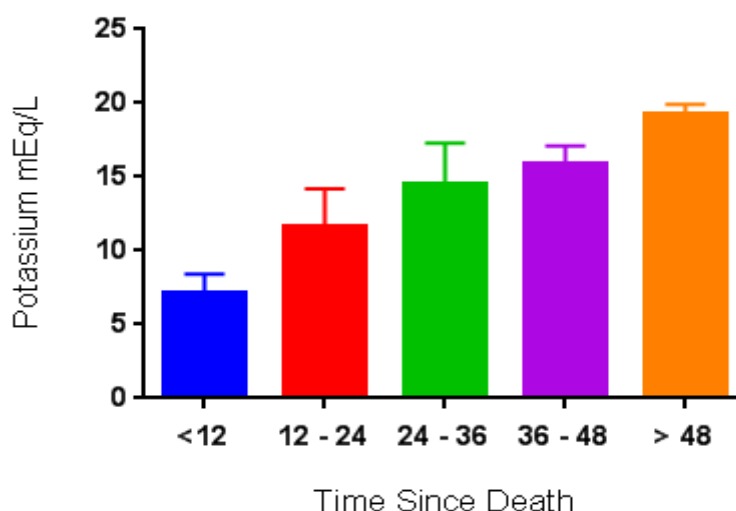


Fig 1: Graphical representation of mean ± SD of vitreous potassium and Time since death p value was <0.0001 (statistically significant)

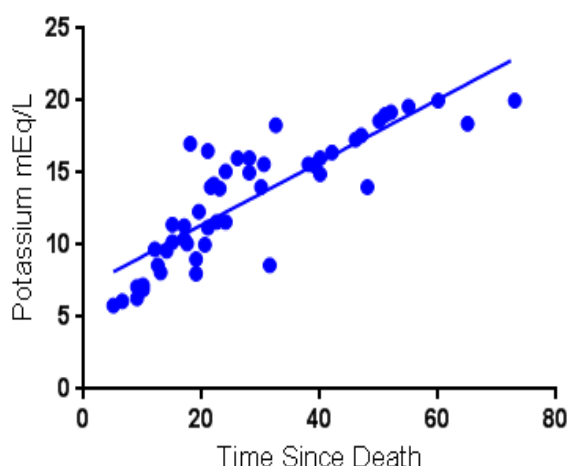


Fig 2: Scatter diagram showing correlation between Time since death and vitreous potassium concentration ($r=0.848$)

IV. Discussion

Different hypotheses have been proposed for the rise in vitreous potassium levels with time after death. Vascular choroid and retinal cells might be the source of this potassium influx[6-10]. According to Naumann et al[11] the influx may be due to the autolysis of cell membranes. Madea et al suggested that breakdown of metabolic mainly anaerobic glycolysis active membrane transport stops and the loss of selective membrane permeability and diffusion of ions and other parameters according to their concentration gradient starts. The fact that intracellular concentration of potassium is much higher than extracellular concentration would support this.

The present study shows that there is considerable rise in the levels of potassium in the vitreous humor with increasing postmortem interval, which appears to be a constant phenomenon in other studies[9,12-16]. In the present study, the analysis of potassium was done by ion selective electrode method, which is the method of choice and is the best solution to avoid errors while analyzing by flame photometry[17]. This method is less likely to have technical errors than other methods used till date.

Factors like age, sex, cause of death did not influence the vitreous humor potassium values[18]. Important environmental factors like humidity and temperature did not have any effect on the levels of potassium, which were in agreement with other studies.[6,14]

V. Conclusion

It is clear from the results of the present study that increased vitreous potassium levels are correlated with increased postmortem interval. We suggest that vitreous potassium can give some indication of approximate time since death. According to us, the combination of the vitreous potassium method and the time tested signs of physical changes after death will improve the accuracy in estimating the time since death.

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