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Original Research Paper

Estimation of Postmortem Interval by Measuring Potassium Level in Vitreous Humour

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Abstract

Establishing the postmortem interval is one of the difficult challenges faced by forensic experts, particularly when limited information about deceased is available. Various methods have been tried to find out the time of death. These include study of physical, chemical, biochemical, histological and enzymatic changes which occur progressively in dead body. The chemical changes to determine the postmortem interval have been increased largely in the last few decades, which are based on changes occurring in the body immediately or shortly after death. These changes occur in various body fluids such as whole blood, serum, CSF, aqueous and vitreous humour. In this study vitreous humour potassium concentration were investigated to predict postmortem interval. In this study we have observed linear rise of vitreous potassium (K^+) ion concentration with increasing post-mortem interval that was both arithmatic as well as logarithmatic (statistically) significant. No significant differences existed for vitreous potassium concentration in the same pair of eyes at identical post-mortem interval. Factors like age, sex, cause of death and environmental temperature did not influence the vitreous humour potassium values.

Key Words: Postmortem interval, Vitreous humour, Potassium

Introduction:

Estimation of time since death is an important part of medico-legal inferences drawn after post-mortem examination. But in reality, it is extremely difficult because timing of onset and the rates of postmortem changes are usually governed by unpredictable endogenous and exogenous factors. [1]

In most cases in our country, time of death is usually estimated from the physical changes noticeable in the dead body. The analysis of body fluid such as vitreous, blood and CSF in relation to their postmortem chemical changes is a useful supplementary procedure. The present study was conducted in Bikaner with the aim to find out the correlation between potassium concentration in vitreous humour vis-a-vis post-mortem interval.

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Vitreous humour is selected because it is relatively stable, easy to sample during postmortem examination and its composition is quite similar to that of aqueous fluid, CSF and serum. It is relatively free from contamination by blood, bacteria and products of the postmortem autolysis. [2]

Aims and Objectives:

- To establish correlation between post-mortem interval and vitreous Potassium concentration.
- To detect difference between level of vitreous potassium concentration in right and left eye, if any.
- To deduce the rate of increase or decrease of vitreous Potassium concentration per hour.
- To derive co-efficient of correlation between postmortem interval and vitreous potassium concentration.
- To derive a formula for determination of postmortem interval within reasonable time limit by putting vitreous potassium concentration.
- Value of vitreous potassium concentration in relation to age, sex, temperature and cause of death.

Material and Methods:

The present study was carried out in Department of Forensic Medicine, in association

with Biochemistry Department of S.P. Medical College & Associate Group of Hospitals, Bikaner on medico-legal cases, which were admitted in S.P. Medical College & Associated Group of Hospitals, Bikaner and died subsequently. The information regarding time of death was collected from hospital records. The samples were taken immediately and send to Department of Biochemistry.

All the cases where the time of death was unknown or body in advanced stage of decomposition or the extracted sample became hemorrhagic or cases of ocular disorder or cases of head injury involving orbit or amount aspirated is less than 0.5 ml were excluded from this study.

The common methods available for vitreous humour biochemistry are spectrophotometer, auto analyzer and emission flame photo meter but here we used ELITE Electrolyte Analyser for estimating potassium level which uses ion selective electrode and is based on ion exchange phenomenon.

Observations and Results:

In this study 127 (63.5%) were males and 73 (36.5%) were females. (Table 1) The majority of cases were from trauma (43%) followed by poisoning (28.50%), Burn (25.50%) and natural death (03%) respectively. (Table 2)

The overall range of time since death was 0 to 72 hrs of studied cases and maximum number of cases were in the range between 12.1 to 24 hrs (37.50%) followed by 6.1 to 12 hrs (29.50%). None of the case was reported beyond 57 hrs of time since death. (Table 3) There was statistically insignificant correlation of vitreous potassium ion concentration in relation to various causes of death. (Table 4)

Discussion:

In this study we observed that there was considerable rise in the vitreous potassium level with increasing postmortem interval. (Table 5)

This linear relationship of the increase in vitreous potassium (K^+) concentration with increase in postmortem interval was both arithmetic and as well as logarithmic. So potassium (K^+) ion level measurement in vitreous humour, is one of the most accurate methods of estimating post-mortem interval.

This observation was supported by many workers [3-9] This course of rise in potassium level in vitreous was due to the autolysis of the vascular choroids and retinal cells of the eye which release substantial amount of potassium into vitreous humour. [10]

Hughes [11], Coe [12], Adjutantis and Coutselinis [13] found that rise of vitreous potassium concentration with post-mortem interval was biphasic in which the slope of the first few hours after death was steeper than for more prolonged times after death which was not observed in this study.

In our study we have noticed linear rise of vitreous potassium concentration up to 57 hrs. We could not estimate potassium concentration beyond 57 hrs as none of the case in our study was reported after 57 hrs of post-mortem interval. We have calculated the following statistics:

1. **Coefficient of correlation**
2. **Coefficient of regression**
3. **Regression equation**

1. Coefficient of Correlation:

It was calculated using INDOSTAT software. The objective of this study was to assess the relationship between the Postmortem interval and potassium ion. The data showed that the coefficient of correlation for potassium (K^+) ion concentration in the vitreous humour was 0.831. This indicates high degree of correlation between postmortem interval and potassium (K^+) ion concentration of vitreous humour. Therefore postmortem interval can be calculated, if vitreous potassium (K^+) ion concentration is known.

2. Coefficient of Regression:

The coefficient of regression was calculated using same INDOSTAT software. The value of coefficient of regression was 3.46 meq/l/hr. It appears that 1meq/l potassium (K^+) ion concentration of vitreous increases in 3.46 hrs of postmortem interval.

3. Regression Equation:

The same was calculated by using INDOSTAT software. The regression equation for each variable is: **Post-mortem Interval = – 16.22 + 3.75 x K^+**

This study showed that there was no statistically significant difference in levels of vitreous potassium concentration between the two eyes of body. Our observations were similar to the other workers. [3, 11, 14, 15] Our findings were not consistent with the reports from Balasooriya et al [16], Madea et al [7] and Pounder et al [17] who found relevant differences between the two eyes.

Singh D et al [18] found that mean vitreous sodium/ potassium ratio was slightly more in left eye then in right eye. However this difference was found statistically insignificant.

In the present study we also could not find any relation between vitreous potassium (K^+) concentration and cause of death. Similar reports were given in the works of Hannsonet al

[19], Balasooriya et al [16] and Ganesh Govekar et al [20] but this result was not consistent with Madea et al [7] who observed that sudden and traumatic death has better correlation between vitreous potassium (K^+) ion concentration and post-mortem interval.

We observed that age and sex factor has no appreciable role in the changes in level of potassium concentration in the vitreous humour after death. But Blumenfield [4] found that the vitreous potassium level rise much more rapidly in the infants than in adults.

From this study it is evident that there was no effect of environmental temperature on the levels of potassium concentration in the vitreous humour after death. (Table 6) This observation was in agreement with the results of other workers. [4]

However Coe [12], Farmer [5] felt that higher environmental temperature at the time of death caused marked enhancement of the observed potassium values in the vitreous humour. Singh D [18] et al found that mean vitreous sodium/potassium electrolytes concentration ratio was more in winter than in summer. Coe [21] in his study observed that external and internal factors influence the post-mortem vitreous biochemistry.

The external factors are sampling techniques, instrumentation and the environmental temperature of the body during the postmortem interval.

The major internal factors possibly influencing the post-mortem vitreous biochemistry are the age of individual, the duration of terminal episode, manner of death and presence or absence of nitrogen retention.

Presently the use of post-mortem vitreous biochemistry for the Post-mortem Interval estimation has been limited because of the different conclusions reached by different workers and the lack of uniformity in their equations. So this topic needs further research to bring into use.

Summary and Conclusion:

From this study, We have observed linear rise of vitreous potassium (K^+) ion concentration with increasing post-mortem interval that was both arithmatic as well as logarithmatic (statistically significant).

On the basis of computer assisted statistical analysis we have developed following statistics for potassium (K^+) ion concentration:-

- Coefficient of correlation was 0.831
- Coefficient of regression was 3.46 meq/l/hr which suggest that the rate of rise of vitreous potassium concentration was 0.29 meq/l/hr.
- Regression equation is: Postmortem Interval= $-16.22+3.75 \times K^+$, Where K^+ = Potassium ion concentration in vitreous.
- Confidence limit = 7.6

No significant differences existed for vitreous potassium concentration in the same pair of eyes at identical post-mortem interval. Factors like age, sex, cause of death and environmental temperature did not influence the vitreous humour potassium values.

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Table 1: Cases According to Age and Gender

Age groups (yrs)	Male	Female	Total (%)
0-10	03	01	04 (2.0)
11-20	23	12	35(17.5)
21-30	48	37	85(42.5)
31-40	27	12	39(19.5)
41-50	15	07	22(11.0)
51-60	05	03	08(4.0)
61-70	04	01	05(2.5)
71-80	01	00	01(.5)
81-90	01	00	01(.5)
Total	**127**	**73**	**200**(100)

Table 2: Cases According to Cause of Death

Causes of Death	Male (%)	Female (%)	Total (%)
Trauma	69(54.33)	17(23.28)	86(43.0)
Burn	20(15.74)	31(42.46)	51(25.5)
Poisoning	33(25.98)	24(32.87)	57(28.5)
Natural Death	05(3.93)	01(1.36)	06(03.0)
Total	**127**	**73**	**200(100)**

Table 6: Comparison of Vitreous Potassium (K^+) ion Concentration According to Temperature in Cases having Approximately Same Time since Death

Temp (°C)	Cases	Range K^+ Conc. (meq/l)	Mean ± SD
10-20	12	3.9 – 15.2	7.9 ± 3.39
20-30	18	3.9 – 10.2	6.8 ± 1.99
30-40	10	4.1 – 16.5	7.6 ± 3.66

Table 3
Cases According to Time since Death and Cause of Death

Time since death (hrs)	Causes of death				Total	%
	Trauma	Burn	Poisoning	Natural Death		
0-1	02	00	00	00	02	01.00
1.1-3	11	06	01	00	18	09.00
3.1-6	17	09	13	00	39	19.50
6.1-12	25	14	17	03	59	29.5
12.1-24	29	19	25	02	75	37.5
24.1-36	01	01	00	00	02	01.00
36.1-48	00	02	00	01	03	01.50
48.1-64	01	00	01	00	02	01.00
64.1-72	00	00	00	00	00	00
Total	**86**	**51**	**57**	**06**	**200**	100.00

Table 4
Vitreous Potassium (K^+) Ion Concentration vis-a-vis Cause of Death

Cause of death	Trauma	Burn	Poisoning	Natural Death
No. of Eyes	**172**	**102**	**114**	**12**
Time since death (hrs)	**K^+ concentration in meq/l**			
0-1	4.10	-	-	-
1.1-3	4.30	4.40	4.20	-
3.1-6	5.40	5.70	4.90	-
6.1-12	7.10	7.00	7.10	7.30
12.1-24	8.50	8.80	8.40	8.10
24.1-36	11.90	12.20	-	-
36.1-48	-	13.90	-	14.30
48.1-72	16.80	-	16.60	-
>72	-	-	-	-

Table 5
Levels of Vitreous Potassium (K^+) ion in Different Age Groups vis-a-vis Postmortem Intervals

Age (yrs)	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	Mean
No. of Eyes	**8**	**70**	**170**	**78**	**44**	**16**	**10**	**2**	**2**	
Time since death (hrs)	**K+ concentration in meq/l**									
0-1	-	4.10	-	4.00	-	-	-	-	-	4.05
1.1-3	-	3.85	4.40	4.40	4.45	4.15	-	-	3.90	4.19
3.1-6	6.30	5.10	5.45	5.60	4.95	5.45	5.15	-	-	5.43
6.1-12	6.95	6.80	7.30	7.20	6.75	6.65	6.55	7.00	-	6.9
12.1-24	8.50	8.40	8.50	8.75	8.60	8.60	-	-	-	8.56
24.1-36	-	-	12.10	-	-	-	-	-	-	12.1
36.1-48	-	-	15.10	-	12.55	14.30	-	-	-	13.98
48.1-72	-	16.60	16.70	-	-	-	-	-	-	16.65
>72	-	-	-	-	-	-	-	-	-	

Table 8
Statistical Correlation of Vitreous Potassium (K^+) Ion Concentration Reported By Various Workers

Workers	Statistical Parameters			
	Coefficient of correlation between (K^+) ion conc. and Postmortem Interval	Rise of Vitreous Potassium (K^+) conc. Up to	Rate of rise of vitreous Potassium (K^+) ion conc/ hour	Confidence limit (hrs)
Sturner et al (1964)	0.987	100 hours	Very Slow	± 4.7 hours
Hughes (1965)	-	100 hours	-	± 20 hours
Hansson (1966)	-	120 hours	0.17 meq/l	± 20 hours
Adelson et al (1969)	-	24 hours	0.17 meq/l	± 10 hours
Coe (1969)	-	24 hours	0.33 meq/l	± 12 hours
Adjustantis & Coupselinis (1972)	-	12 hours	0.73 meq/l	± 3.3 hours
Agarwal RL et. Al (1983)	0.985	24 hours	0.52 meq/l	± 3.39 hours
Stephens & Richards (1987)	-	-	0.238 meq/l	± 20 hours
Madea et al (1989)	-	120 hours	0.203 meq/l	± 20 hours
Govekar et al (1990)	0.855	60 hours	0.15 meq/l	± 5.70 hours
Present Study (2013)	0.831	57 hours	0.29 meq/l	± 7.6 hours