

Estimation of Time since Death by Potassium Ion (K⁺) Level In Cerebrospinal Fluid- A Postmortem Study

Bhanwar Lal Jakhar¹, O.P. Saini², P.K. Saini³, Sanjeev Buri⁴, Shalender Saharan⁵

¹Resident Doctor, ²Associate Professor & Head, ³Associate Professor, ^{4,5}Assistant Professor

Deptt. Of Forensic Medicine & Toxicology, S.P. Medical College, Bikaner, (Rajasthan)

Corresponding Author: O.P. Saini, Associate Professor & Head, Deptt. of Forensic Medicine & Toxicology, S.P. Medical College, Bikaner, (Rajasthan)

Type of Publication: Original Research Paper

Conflicts of Interest: Nil

Abstract

Background: A precise estimation of post-mortem interval (PMI) is a useful statistics while examining a missing persons file in search of a likely match, establishing the time frame of crime, narrowing the field of suspects during police inquiry in an unwitnessed crime, solving the civil cases like dispute in property inheritance and insurance policies etc. Estimating accurate PMI has always posed a challenge for the autopsy surgeon.

Methods: This study was carried out in department of Forensic Medicine and Toxicology S.P. Medical College and A.G. of Hospitals, Bikaner. Epidemiological data viz. age, gender, occupation, date and time of incident will be collected from patient, their relatives and Bed Head Ticket (BHT). These data along with K⁺ level and post mortem examination was recorded in specially designed proforma.

Result: In our study less than 10 yrs age autopsy K⁺ level was 6.40±2.00 meq/l, 11-20 yrs age group autopsy K⁺ level was 6.32±2.44 meq/l, 21-30 yrs age group autopsy K⁺ level was 7.02±1.86 meq/l, 31-40 yrs age group autopsy K⁺ level was 6.84±2.01 meq/l, 41-50 yrs age group autopsy K⁺ level was 6.58±1.87 meq/l, 51-60 yrs age group autopsy K⁺ level was 6.10±2.08 meq/l.

In RTA case autopsy K⁺ level was 6.80±1.40 meq/l, in poisoning case autopsy K⁺ level was 6.24±2.08 meq/l, in hanging case autopsy K⁺ level was 7.28±2.04 meq/l, in drowning case autopsy K⁺ level was 6.90±2.12 meq/l, in burns case autopsy K⁺ level was 6.27±1.28 meq/l, in septicaemia case autopsy K⁺ level was 6.42±2.14 meq/l.

Conclusion: Our study did not show any reasonable variation in K⁺ level of CSF in to the cause of death and age.

Keywords: Time since death, K⁺ level, CSF, Autopsy

Introduction

A precise estimation of post-mortem interval (PMI) is a useful statistics while examining a missing persons file in search of a likely match, establishing the time frame of crime, narrowing the field of suspects during police inquiry in an unwitnessed crime, solving the civil cases like dispute in property inheritance and insurance policies etc. Estimating accurate PMI has always posed a challenge for the autopsy surgeon.

Biochemical analysis as useful indicator for estimating PMI has already been presented by some authors.

Data have been reported of a significant correlation between the postmortem concentration of some biochemical parameters such as potassium, urea, glucose, lactate, hypoxanthine, glycated hemoglobin, calcineurin A, phosphatase troponin, cytochrome c oxidase, lactate and malate dehydrogenase, gamma amino butyric acid and PMI in distinct biological matrices (e.g. vitreous humor, blood, cerebrospinal and synovial fluids).¹⁻³

CSF is unique fluid, resistant to putrefaction for a long time and most sterile. CSF containing biochemical constituents, especially potassium, have been used in the postmortem interval (PMI) estimations. The time dependant rise of CSF bio chemical parameters in the post-mortem period has been considered to be helpful in PMI determinations. So this study was carried out from potassium level in CSF and to formulate the practical method for estimation of time since death.

Materials & Method

This study was carried out in department of Forensic Medicine and Toxicology S.P. Medical College and A.G. of Hospitals, Bikaner.

Epidemiological data viz. age, gender, occupation, date and time of incident will be collected from patient, their relatives and Bed Head Ticket (BHT). These data along with K⁺ level and post mortem examination was recorded in specially designed proforma.

Finally the details was analyzed and the conclusions will be drawn after comparing and discussing with similar type of the work carried out by foreign and Indian authors.

This study was conducted on total 100 number of cases.

Inclusion Criteria

Cases of all age group which were admitted in P.B.M. Hospital, Bikaner, (Raj) was included in the study.

Exclusion Criteria

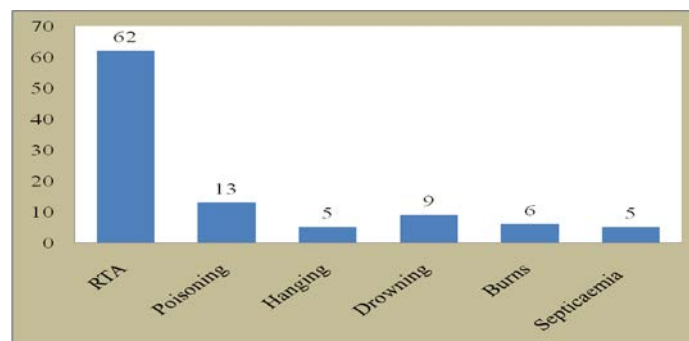
1. All those cases where the time of death was unknown or body in advance state of decomposition.
2. The cases of head injuries/ vertebral column and spinal cord injuries.
3. The cases in which the extracted sample in turbid/cloudy/yellow.
4. Cases in which due to any reason the extracted sample in contaminated with blood or became haemorrhagic.

Data Analysis

To collect required information from eligible patients a pre-structured pre-tested Proforma was used. For data analysis Microsoft excel and statistical software SPSS was used and data was analyzed with the help of frequencies, figures, proportions, measures of central tendency, appropriate statistical test.

Observations

Out of 100 cases, 27.00% cases were 51-60 yrs age group followed by 16.00% cases were 41-50 yrs age group, 15.00% cases were 31-40 yrs age group and 16.00% cases were more than 60 yrs age group. 51-60 years age groups are more productive and hence more vulnerable to road traffic accidents, occupational hazards, suicidal tendency and homicidal activity in country like India. Out of 100 cases, 53.00% cases were male and 47.00% cases were female.



Out of 100 cases, 62 death were due to RTA followed by 13.00% death were due to poisoning , 9 death were due to

Drowning , 6.00% death were due to burns, 5.00% death were due to hanging and 5.00% death were due to septicaemia.

Table 1 Time since death

| Time(Hours) | No. of cases | Percentage |
|-------------|--------------|------------|
| 0-12 | 70 | 70.00% |
| 13-24 | 23 | 23.00% |
| 25-36 | 5 | 5.00% |
| 37-48 | 1 | 1.00% |
| 49-72 | 1 | 1.00% |
| Total | 100.00 | 100.00% |

In 70.00 % cases sample was collected within 12 hours after death , in 23 % cases within 13-24 hours, in 5% cases within 25-36 hours.

Table 2. K Level

| | K level |
|------|------------|
| Mean | 6.79 meq/l |
| SD | 1.53 |

Mean K level was 6.79±1.53 mEq/L.

Table 3. Association of K level with time since death

| Time | No. of cases | K level | |
|---------|--------------|---------|------|
| | | Mean | SD |
| 0-12 | 70 | 5.97 | 0.51 |
| 13-24 | 23 | 8.13 | 0.27 |
| 25-36 | 5 | 11.34 | 0.42 |
| 37-48 | 1 | 11.36 | 0 |
| 49-72 | 1 | 12.58 | 0 |
| p-value | 0.001 | | |

Mean K level 5.97±0.51 was found in within 12 hours duration cases followed by 8.13±0.27 was found in within 13-24 hours duration cases, 11.34±0.42 was found in within 25-36 hours duration cases, 11.36±0.0 was found in within 37-48 hours duration cases and 12.58±0.0 was found in within 49-72 hours duration cases.

Table No 4. Correlation between the time since death and K level

| | Mean | Std. Deviation | R | R Square | Sig. F Change |
|--------------------------|-------|----------------|------|----------|---------------|
| Time since death (hours) | 11.08 | 2.53 | 0.82 | 0.64 | 0.000 |
| K level (meq/l) | 6.79 | 1.53 | | | |

A significant inverse fair correlation existed between the time since death and K level (r = 0.82, p < 0.001) by using Pearson's correlation coefficient.

Table 5. Association between age and K⁺ level

| Age group | No. of cases | K level | |
|--------------|--------------|---------|------|
| | | Mean | SD |
| Less than 10 | 2 | 6.40 | 2.00 |
| 11-20 | 10 | 6.32 | 2.44 |
| 21-30 | 14 | 7.02 | 1.86 |
| 31-40 | 15 | 6.84 | 2.01 |
| 41-50 | 16 | 6.58 | 1.87 |
| 51-60 | 27 | 6.10 | 2.08 |
| More than 60 | 16 | 6.04 | 1.98 |
| p-value | 0.541 | | |

In our study less than 10 yrs age autopsy K⁺ level was 6.40±2.00 meq/l, 11-20 yrs age group autopsy K⁺ level was 6.32±2.44 meq/l, 21-30 yrs age group autopsy K⁺ level was 7.02±1.86 meq/l, 31-40 yrs age group autopsy K⁺ level was 6.84±2.01 meq/l, 41-50 yrs age group autopsy K⁺ level was 6.58±1.87 meq/l, 51-60 yrs age group autopsy K⁺ level was 6.10±2.08 meq/l.

Table 6. Association between cause of death and K level

| Cause of death | No. of cases | K level | |
|----------------|--------------|---------|------|
| | | Mean | SD |
| RTA | 62 | 6.80 | 1.40 |
| Poisoning | 13 | 6.24 | 2.08 |
| Hanging | 5 | 7.28 | 2.04 |
| Drowning | 9 | 6.90 | 2.12 |
| Burns | 6 | 6.27 | 1.28 |
| Septicaemia | 5 | 6.42 | 2.14 |
| p-value | 0.730 | | |

In our study in RTA case autopsy K⁺ level was 6.80±1.40 meq/l, in poisoning case autopsy K⁺ level was 6.24±2.08 meq/l, in hanging case autopsy K⁺ level was 7.28±2.04 meq/l, in drowning case autopsy K⁺ level was 6.90±2.12 meq/l, in burns case autopsy K⁺ level was 6.27±1.28 meq/l, in septicaemia case autopsy K⁺ level was 6.42±2.14 meq/l.

Discussion

The hospital based prospective study was conducted on cases coming for medico legal post-mortem examination to the Department of Forensic Medicine and toxicology, S.P. Medical College & Associated group of P.B.M. Hospital, Bikaner, Rajasthan, during the one year period.

Postmortem biochemistry is an important, but seldom practised tool in death investigations. Biochemical analyses of different biological fluids such as blood, vitreous humor, urine, cerebrospinal fluid, synovial, pleural and pericardial fluids are not only important in cases of sudden natural deaths, but also in estimation of time since death, in detection of various poisons, and for better understanding of pathophysiology of disease process³.

Coe (1993) considered forensic biochemistry as one of the important ancillary procedures to be followed by a

forensic pathologist⁴. The necessity of such investigations should be decided on case to case basis. In cases of hospital deaths, the samples collected and investigations results obtained during the course of treatment should be taken into consideration. The autopsy surgeon should have the knowledge about the selection of sample in a particular case and at the same time should have the knowledge of preservation and techniques of collection of such biological samples. It is important to follow the correct sampling procedures as well as its proper preservation, as reliability of laboratorial results is dependent upon all these factors. A brief history, nature of the sample and the preservative used should be clearly mentioned in the laboratory request form. The analysis report will thus provide the scientific foundation that will help in the corroboration of investigators' theory, which can be used in administration of justice in the court of law. Due to lack of proper guidelines for collection of biological samples during post-mortem examination, the results of such investigations are often adversely challenged in courts. Not only that many a times the autopsy surgeon neglects to preserve the biochemical samples, and even if he collects, there exist faulty sampling methods or inefficient preservation due to which vital findings are missed or destroyed. Hence we have made an effort to standardize the sampling method for biochemical analysis in post-mortem cases, so that consistent comparisons to the database can be achieved.⁵ Out of 100 cases, 62 death were due to RTA followed by 13.00% death were due to poisoning, 9 death were due to drowning, 6.00% death were due to burns, 5.00% death were due to septicemia and 5.00% death due to hanging in our study.

Due to the fast pace of modernization, basic needs including the requirement of a vehicle for transportation

are expanding rapidly and resulting in an epidemic situation of injury everywhere including developing countries.

According to the World Health Report 2016, of the global burden of injury, 30.3% morbidity and 28.7% mortality occurred in the South-East Asia Region. Road traffic injuries are among the three leading causes of death for people between 5 and 44 years of age and most common cause of death for people between 5 to 25 years of age.⁶

In 70.00 % cases sample was collected within 12 hours after death , in 23 % cases within 13-24 hours, in 5% cases within 25-36 hours in our study.

Mason J K et al⁷ was found that fifty-eight samples were obtained from 46 bodies one and a half to 70 hours after death, and the potassium level estimated with the flame photometer.

Umang P Patel et al⁸ was found that most cases samples were collected within 12-24 hours of death followed by 0-12 hours and 24-36 hours of death. And few samples were collected with more than 48 hours post mortem interval.

In our study mean K level 5.97 ± 0.51 mEq/L was found in within 12 hours duration cases followed by 8.13 ± 0.27 mEq/L was found in within 13-24 hours duration cases, 11.34 ± 0.42 mEq/L was found in within 25-36 hours duration cases, 11.36 ± 0.0 mEq/L was found in within 37-48 hours duration cases and 12.58 ± 0.0 mEq/L was found in within 49-72 hours duration cases. Correlation coefficient (r) between time since death and k Level was found 0.82. It is significant positive correlation.

Mason J K et al⁷ was also found that the concentration increases during this period in proportion to the logarithm of the time since death.

Yadav J et al⁹ revealed a significant correlation of sodium and potassium ions in CSF up to 25 h of time since death, with average per hour rise of 1.21 meq/h for potassium

and fall of 1.115 meq/h for sodium ions. A useful relationship between sodium potassium ion ratio and PMI (post-mortem interval) was also elicited.

Urban et al¹⁰ was observed that K⁺ levels value in CSF a stronger relations with time since death and rise was not influenced by environmental temp.

Yadav J et al⁹ observed that potassium level was increased with 1.21 meq/hours.

Adelson et al¹¹ used 349 samples from 269 cases. No significant difference was noted in the K⁺ levels of two eyes as determined by flame photometry.

Mulla A et al¹² hypothesised in his study that the concentration of vitreous biochemical constituents in the same pair of eyes change at the same rate and this change that occurs in a time dependent fashion may be utilized in accurately estimating the post mortem interval. There was a linear rise of potassium values ranging from 7.04 mEq/L to 15.81 meq/, which is comparable to the values reported by Govekar G et al¹³. In his study, case of the lower value of potassium was reported to be 3.56 mEq/L, wherein in our study we have found higher levels of potassium i.e., 6.79 ± 1.53 mEq/L.

Nauman et al¹⁴ and Schleyer et al¹⁵ was found that potassium level estimation time since death was a unreliable markers.

$$Y = 0.2x + 4.5748$$

It was calculated using Epi-info 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 CSF was 0.2. This indicates high degree of correlation between postmortem interval and potassium (K⁺) ion concentration of CSF. Therefore postmortem interval can be calculated, if CSF potassium (K⁺) ion concentration is known.

In our study less than 10 yrs age autopsy K⁺ level was 6.40±2.00 meq/l, 11-20 yrs age group autopsy K⁺ level was 6.32±2.44 meq/l, 21-30 yrs age group autopsy K⁺ level was 7.02±1.86 meq/l, 31-40 yrs age group autopsy K⁺ level was 6.84±2.01 meq/l, 41-50 yrs age group autopsy K⁺ level was 6.58±1.87 meq/l, 50-60 yrs age group autopsy K⁺ level was 6.10±2.08 meq/l.

Analysis based on age does not show appreciable role in change in the level of concentration of K⁺ ion in CSF

In our study in RTA case autopsy K⁺ level was 6.80±1.40 meq/l, in poisoning case autopsy K⁺ level was 6.24±2.08 meq/l, in hanging case autopsy K⁺ level was 7.28±2.04 meq/l, in drowning case autopsy K⁺ level was 6.90±2.12 meq/l, in burns case autopsy K⁺ level was 6.27±1.28 meq/l, in septicemia case autopsy K⁺ level was 6.42±2.14 meq/l.

In our study and our study did not show any reasonable variation in K⁺ level of CSF in to the cause of death.

Sanjay choudhary et al¹⁶ conducted a study of K⁺ level in CSF upto 48 hours of time since death and observed that consistently increased K level with time since death. His observation are in accordance with our finding.

V. Rama¹⁷ conducted a study on 100 samples of CSF and observed an increased in the level of K⁺ ion in CSF with time since death except during 12 to 18 hours of time since death. His observation are inconsistent with our findings.

Conclusion

Our study did not show any reasonable variation in K⁺ level of CSF in to the cause of death and age.

References

1. Lendoiro E, Cordeiro C, Rodriguez-Calvo M S. Applications of Tandem Mass Spectrometry (LC-MSMS) in estimating the post-mortem interval

using the biochemistry of the vitreous humour, *Forensic Sci. Int.*, 2012;223:160–164.

2. Uemura K, Shintani-Ishida K, Saka. Biochemical blood markers and sampling sites in forensic autopsy, *J. Forensic Leg. Med.*, 2008; 15:312–317.
3. Choo-Kang E, McKoy C, Escoffery C. Vitreous humor analytes in assessing the postmortem interval and the antemortem clinical status. *West Indian Med J.* 1983; 32: 23- 26.
4. Prasad BK, Choudhary A, Sinha JN. A study of correlation between vitreous potassium level and post mortem interval. *Kathmandu Univ Med J (KUMJ)*. 2003 Apr-Jun; 1(2):132-4.
5. The biochemistry of body fluids. 2009. Available at: <http://www.acbi.ie/Downloads/Guidelines-of-Body-Fluids.pdf>. Accessed 1 April 2019.
6. World Health Report 2016, WHO, Geneva.
7. Mason J K, Klyne W, And Bernard Lennox. Potassium levels in the cerebrospinal fluid after death. *J. clin. Path.*, 1952, 4, 231.
8. Umang P Patel, Jigneshkumar Patel, Pranav Prajapati, Ganesh Govekar. A study to evaluate of time since death from potassium level of vitreous humour. *NJCMR*, 2016;3 (6):255-60.
9. Yadav J, Deshpande A, Arora A, Athawal BK, Dubey BP. Estimation of time since death from CSF electrolyte concentration in Bhopal region of central India. *Leg Med (Tokyo)*. 2007 Nov;9(6):309-13.
10. Urban R. Collection, preservation and forwarding of biological samples for toxicological analysis in medico-legal autopsy cases: A review. *J Indian Acad Forensic Med* 2008; 30(2):96- 100.

11. Adelsonl, Maria-del ML, Sabatasso S, Mangin P, Augsburger M, Sporkert F. Usefulness of postmortem biochemistry in forensic pathology: Illustrative case reports. *Legal Med* 2012 jan;14(1):27–35.
12. Mulla . Collection and preservation of the pleural fluid and pleural biopsy. *J bras. Pneumol* 2006;32(4):174-8.
13. Gorver, Maria-del ML, Sabatasso S, Mangin P, Augsburger M, Sporkert F. Usefulness of postmortem biochemistry in forensic pathology: Illustrative case reports. *Legal Med* 2012 jan;14(1):27–35.
14. Nauhman. *Medico-legal postmortems in India: Medical Publications; 1985. p. 44-6.*
15. Schleyer. An overview of methods used for estimation of time since death, *Austr. J. Forensic Sci.*, 1957,12, 275–285.
16. Choudhary S. Estimation of *Post-Mortem* Interval from the Changes in Vitreous and CSF. Thesis submitted in rajasthan university 2002-2004.
17. Rama V. Assessing time since death by using changes in electrolytes in CSF. Repository-tnmgrmu.ac.in/8945/. Last acesed on 26 march 2019.