Original Article

Postmortem period estimation through measuring potassium and glucose in synovial fluid and vitreous humor

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ABSTRACT

Background: The time that elapses after death of an individual can be estimated by observing certain events and changes that occur in the cadaver following the cessation of life. One such change involves the biochemical alterations in the components of the vitreous humor and synovial fluid. These changes can be identified by performing chemical analysis of these fluids. Due to the distinct separation of these fluids within their respective cavities, they are suitable for chemical analysis without being influenced by external factors or hazards. **Aim:** This research aims to estimate the postmortem period through measuring potassium and glucose levels in synovial fluid and vitreous humor. **Material and method:** This work utilizes chemical analysis to detect and study the biochemical changes that occur in these fluids at 8, 16 and 24 hour postmortem intervals. By examining the levels of potassium and glucose in each cavity, researchers can estimate the postmortem interval, which refers to the time that has elapsed since the person's death. **Results:** The current study involved the examination of 53 deceased individuals who had been subjected to car accidents. Samples were collected from both the vitreous and knee cavities at 8, 16 and 24 h intervals following the accidents. These samples were then subjected to analysis to determine the levels of potassium and glucose. According to the findings of the study, there was a statistically significant and consistent increase in the levels of potassium, along with a progressive decrease in the level of glucose observed in both the vitreous humor and synovial fluid, which was directly proportional to the increase in time intervals. **Conclusion:** potassium and glucose analysis of aspirated vitreous humor and synovial fluid was a valuable tool for estimating the postmortem period.

Key words:vitreous humor,synovial fluid,potassium,glucose.

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I.INTRODUCTION

The assessment of time since death (TSD) or postmortem interval (PMI) holds significant importance in legal contexts, guiding appropriate civil and criminal consequences. TSD is intricately influenced by an array of internal and external factors, encompassing preexisting diseases, ambient environmental conditions determining humidity and temperature, and the thermodynamics associated with the final terminal actions leading to death. In contemporary forensic practices, advanced methodologies such as chemical analysis play a vital role in determining TSD. The agonal stages of death mark the onset of numerous biochemical changes attributed to factors like reduced oxygen levels in the blood, alterations in enzyme reactions, and a cessation in metabolite production. These physiological shifts are mirrored in various bodily fluids, and the analysis of metabolite profiles offers valuable insights for estimating the elapsed time since death.(Sruthi et al.,2023)

"Closed compartments" like cerebrospinal fluid, synovial fluid, and vitreous humor emerge as particularly advantageous for evaluating post-mortem changes. Vitreous humor, in particular, stands out as a preferred medium for assessing post-mortem electrolyte concentrations. Its closed nature and relative isolation make it less susceptible to external influences, providing a more stable environment for analyzing electrolyte levels, which can be crucial in estimating the post-mortem interval (PMI). Similarly, synovial fluid, found in joints, presents itself as an alternative source for PMI estimation. These closed compartments offer a controlled setting that helps minimize the impact of external factors, enhancing the accuracy of forensic analyses in determining the time since death.(Woharndee et al.,2020)

Synovial fluid, similar to vitreous humor, has been largely overlooked in postmortem chemistry. Yet, it offers distinct advantages, being better protected and less affected by burns or atmospheric changes compared to other body fluids. Its potential for accurately estimating the postmortem interval holds great promise in forensic investigations, providing valuable insights into the time of death with unprecedented precision. Nevertheless, further research and validation are needed to fully utilize synovial fluid for postmortem analysis. (Bhargava et al.,2021)

Potassium, a vital electrolyte, is present in substantial concentrations in body fluids such as cerebrospinal fluid, aqueous humor, vitreous humor, blood, serum, and synovial fluid. After death, its levels undergo changes attributed to factors like the breakdown of cellular membranes and the release of intracellular potassium. Forensic investigators utilize potassium measurements in these fluids to estimate the time since death (TSD). Vitreous humor, a transparent gel-like substance in the eye, composed of collagen fibers and hyaluronan, contains electrolytes including Na^+, K^+, Cl^-, Ca^{++}, and Mg^{++}. The average potassium level in vitreous humor is approximately 3.8 mmol/l. Synovial fluid, responsible for joint lubrication and cushioning, comprises hyaluronic acid, proteinases, collagenases, lubricin, Na^+, K^+, Ca^{++}, and glucose. Accurate TSD estimation is achieved through analyzing potassium levels in vitreous humor and synovial fluid, with studies indicating the latter's precision as particularly noteworthy.(Rangaiah et al.,2023)

In the late 1960s, researchers sought alternative fluids for studying postmortem changes that remained more stable than blood. Investigations focused on pericardial fluid, synovial fluid, and vitreous humor due to their slower autolytic changes. Postmortem blood glucose concentration proved unreliable for estimating blood glucose levels, given significant fluctuations after death. Presently, various forensic science disciplines contribute to multiple approaches for estimating the postmortem interval (PMI). One method involves assessing glucose concentration in vitreous humor, chosen for its accessibility and protective position, offering advantages over other tissues in resisting putrefaction.(Clivia et al.,2018)

This study aimed to investigate changes in potassium electrolyte and glucose levels in vitreous humor and synovial fluid collected from the same corpse at different time intervals. We aimed to assess the reliability of these changes in estimating the Postmortem Interval (PMI). Analyzing the variations in these biomarkers over time will provide valuable insights into their potential as indicators for determining the time since death.

II.MATERIAL AND METHOD

The present study was carried out on 53 dead human(27 males and 26 females) at different age from 25-85 years old after car accident which were brought to the mortuary of Fayoum Government General Hospital. From the 1st of January 2022 till the end of June 2022.

Inclusion criteria

Death after car accident , the cases whose exact times of death were known were selected for the study. Details of these cases were obtained from the hospital records, police records, relatives and friends.

Exclusion criteria

- Knee injury
- Eye injury
- Diabetic cases were excluded from the study to avoid potential misinterpretation of glucose measurements.

Method

The cases were divided according to the time since death into three groups according to time intervals(8 ,16 ,24 hours postmortem) for synovial fluid and vitreous humor.

Synovial fluid was obtained from both the right and left knees by puncturing the lateral end of the knee joint below the patella,as shown in image1&2. Approximately 1-1.5 ml of clear fluid was aspirated using a syringe. The collected samples underwent centrifugation at 3500 rpm for 10 minutes. The resulting supernatant fluid was then analyzed for K and Glucose.(Madea et al.,2001)

This aspiration process was repeated three times: the first two aspirations were performed at 8 and 24 hours after death from the right knee, while the third aspiration was carried out 16 hours after death from the left knee.

Image 1 Rt knee

Image 2 Lt knee

A clear vitreous humor sample, measuring approximately 1-1.5 ml, was obtained by gently puncturing near the outer canthus without applying pressure. Lid retraction was performed prior to the aspiration procedure. The collected samples underwent centrifugation at 3500 rpm for 10 minutes. The resulting supernatant fluid was then analyzed for K and glucose. This aspiration process was repeated three times: first at 8 and 24 hours after death from the right eye, and then at 16 hours after death from the left eye.

Glucose measured through colorimetric method using glucose oxidase to catalase oxidation of glucose to gluconic acid measured by spectrophotometer at wave length 505nm.(Raba and Mottola, 1995)

Potassium measurement through ion selective electrode technique using easy-lyte analyzer Chairon model.(Burnett et al., 2000)

Statistical analysis:

The collected data was presented as means ± standard deviation for
all parameters. A repeated measures ANOVA test, followed by Bonferroni correction for multiple comparison, was used to compare the statistical significance for the repeated measures. Values of $p \leq 0.05$ were considered statistically significant. Univariate regression analysis was performed to predict an equation calculating postmortem time by using SPSS 23.

Ethical consideration

The study received ethical approval from the Faculty of Medicine, Fayoum University, ethical committee number (102) R_ 411 , at the date 15/1/2023.In compliance with the guidelines and regulations for medical practice and Helsinki declaration.

III.RESULTS

A total of 53 individuals were examined in this study, consisting of 27 males and 26 females as shown in **figure (1)**. The gender distribution within the sample population was fairly balanced, with almost equal representation from both sexes. The males represent 50.9% and females 49.1%.

The mean age of the studied humans was (62.53± 11.74) with minimum age 25 and maximum 85 year old, as shown in **(Table 1).**

Table 1. Age distribution among study population (total 53)

Age	number	percent	mean age
25-34	2	3.8	(62.53± 11.74)
35-44	3	5.7	
45-54	4	7.5	
55-64	22	41.5	
65-74	16	30.2	
75-85	6	11.3	
total	53	100	

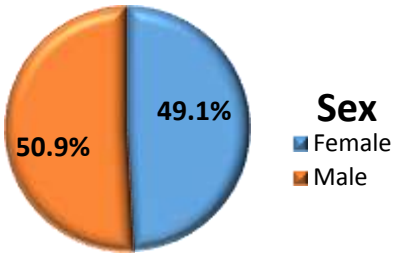

Figure 1. Gender of the study groups

The findings of the current study demonstrated a consistent and progressive elevation in the potassium (K) levels observed in both the vitreous humor and synovial fluid following death, where we found that potassium level showed continuous rise postmortem as it was 2.996±0.4942 at 8 hours postmortem in synovial fluid , to be 4.055±0.4598 at 16 hours postmortem, to reach 5.079±0.5792 at 24hours postmortem, p<0.001*, where that potassium level in Vitreous showed continuous rise postmortem as it was 3.055± 0.0.4964 at 8 hours postmortem , to be 4.092 ±0.4292 at 16 hours postmortem, to reach 5.151± 0.573at 24hours postmortem, p<0.001*, as shown in (**table 2, figure 2).**

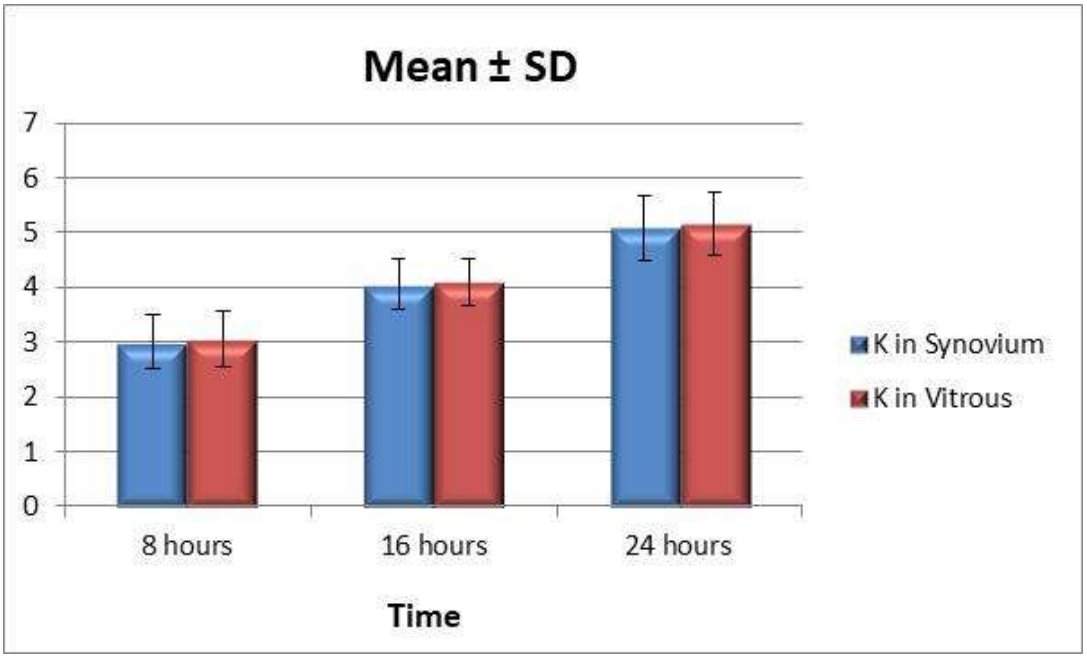

Figure 2. Shows the K level in synovial fluid &vitreous humor

Table 2. Comparison of K level in synovial and vitreous in different groups of the study at postmortem period by using repeated measures ANOVA test and Bonferroni correction (Number of cases =53).

Parameter	K in Synovial			K in Vitreous		
Groups	8 hours	16 hours	24 hours	8 hours	16 hours	24 hours
Mean± standard. Deviation	2.996± 0.4942	4.055± 0.4598	5.079± 0.5792	3.055± 0.4964	4.092± 0.4292	5.151± 0.573
P-value 8 hours vs 16 hours	<0.001*			<0.001*		
P-value 16 hours vs 24 hours		<0.001*			<0.001*	
P-value 8 hours vs 24 hours	<0.001*			<0.001*		

* significant value
K : Potassium
ANOVA : Analysis of variance

According to the findings of the present study, there was a consistent and progressive decrease in the glucose levels observed in both the vitreous humor and synovial fluid following death, where we found that glucose level showed continuous decrease postmortem as it was 87.49± 9.609 at 8 hours postmortem in synovial fluid , to be 61.58± 7.289 at 16 hours postmortem, to reach 39.53± 5.5, at 24 hours postmortem,p<0.001, where that glucose level in Vitreous showed continuous decrease postmortem as it was 88.34± 9.18 at 8 hours postmortem, to be 62.08± 6.886 at 16 hours postmortem, to reach 39.91± 5.429 at 24 hours postmortem,p<0.001 as shown in **(table 3, figure 3).**

Table 3. Comparison of Glucose level in synovial and vitreous in different groups of the study at postmortem period by using repeated measures ANOVA test and Bonferroni correction(Number of cases =53).

Parameter	GL in Synovial			GL in Vitreous		
Groups	8 hours	16 hours	24 hours	8 hours	16 hours	24 hours
Mean± standard. Deviation	87.49± 9.609	61.58± 7.289	39.53± 5.5	88.34± 9.18	62.08± 6.886	39.91± 5.429
P-value 8 hours vs 16 hours	<0.001*			<0.001*		
P-value 16 hours vs 24 hours		<0.001*			<0.001*	
P-value 8 hours vs 24 hours	<0.001*			<0.001*		

* significant value
GL: Glucose Level
ANOVA : Analysis of variance

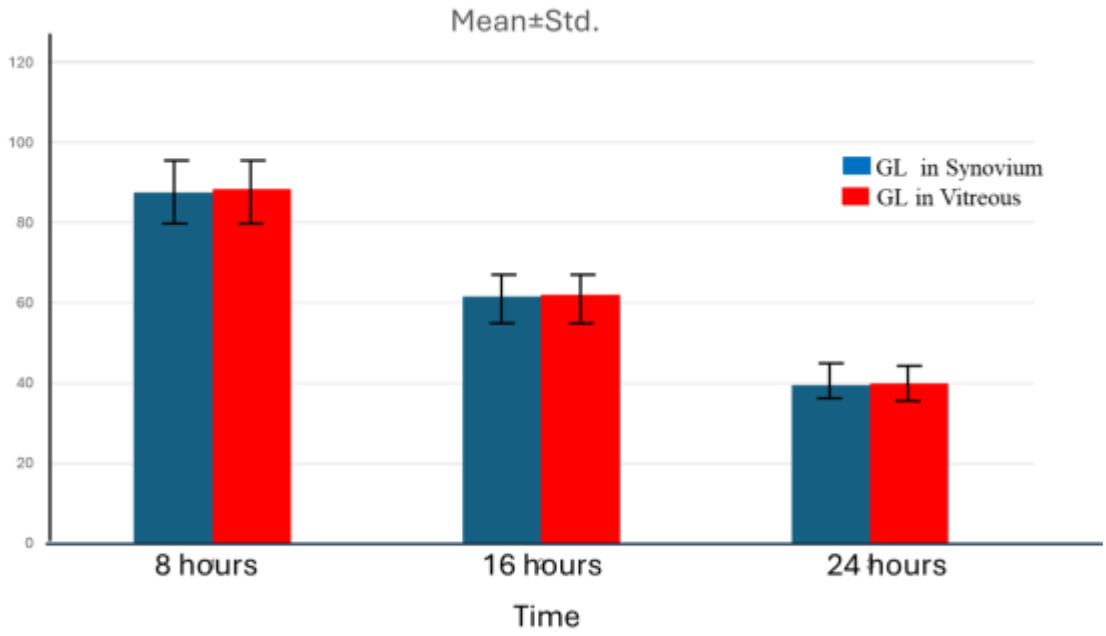

Figure 3. Shows the Glucose level in synovial fluid &vitreous humor

The statistical analysis using repeated measures ANOVA revealed a highly significant p-value when estimating the levels of glucose and potassium in both synovial fluid and vitreous humor. **(Table 4),** demonstrating a strong R2 value greater than 0.75 for the glucose levels (.867 - .879) in both synovial fluid and vitreous humor, along with a significant p-value. Additionally, a moderate R2 value ranging from 0.50 to 0.74 was observed for the potassium levels(.735 - .745) in synovial fluid and vitreous humor, also with a significant p-value. These findings indicate a strong correlation between the levels of glucose and potassium in these body fluids and the postmortem interval. The statistical significance supports the use of glucose and potassium levels as potential markers for determining the postmortem interval in forensic investigations.

There is a continuous increase in potassium levels in the synovial fluid with increase postmortem interval. The statistical analysis revealed a linear increase with a correlation coefficient of .735 and a highly significant p-value of 0.000. Univariate regression analysis was performed, resulting in the estimation of an equation (T=6.873+5.657×K) to estimate the postmortem interval (T) based on the potassium level in the synovial fluid.

The statistical analysis revealed a strong positive relation with a correlation coefficient of .745 and a highly significant p-value of 0.000. To further explore this relationship, univariate regression analysis was performed, resulting in the estimation of an equation (T=7.369+5.701×K). This equation allows for the estimation of the postmortem interval (T) based on the potassium level in the vitreous humor.

The present study revealed a linear decrease in glucose levels in the synovial fluid following death. The statistical analysis demonstrated a correlation coefficient of .867 and a highly significant p-value of 0.000, indicating a strong negative relationship. Through univariate regression analysis, an equation (T=34.205-0.290×GL) was derived to estimate the postmortem interval (T) based on the glucose level in the synovial fluid. The findings of the

current study showed a consistent and linear decrease in glucose levels in the vitreous humor following death. The statistical analysis revealed a strong negative relation with a correlation coefficient of .879 and a highly significant p-value of 0.000. Univariate regression analysis was conducted to further investigate this relationship, resulting in the estimation of an equation (T=34.429-0.290×GL). This equation allows for the estimation of the postmortem interval (T) based on the glucose level in the vitreous humor.

Table 4. Univariate Regression Analysis for determination of PMI(Number of cases =53).

Parameters	K in Synovial	K in Vitreous	Glucose in Synovial	Glucose in vitreous
R^2	.735	.745	.867	.879
P-Value	<0.001*	<0.001*	<0.001*	<0.001*
Co	-6.873 5.657 .858	-7.369 5.701 .864	34.205 -.290 -.932	34.429 -.290 -.938
E	T=6.873+5.65 7×K	T=7.369+5.70 1×K	T= 34.205- 0.290×GL	T= 34.429- 0.290×GL

R= Correlation(weak 0.00-0.24,fair 0.25-0.49,moderate 0.50-0.74,strong 0.75-1.00) P-Value significant <0.0005 Co= Coefficients T= Post mortem interval E= Equation for simple regression analysis to calculate T

IV.Discussion

The findings of the current study demonstrated a consistent and progressive elevation in postmortem potassium levels observed in both the vitreous humor and synovial fluid with direct proportion to the postmortem interval. This coincide with the study that revealed a continuous rise in potassium ion concentration in both vitreous humor and synovial fluid throughout the data collection period. Notably, the potassium ion levels in vitreous humor showed a significant increase at the 12-hour post-mortem, while synovial fluid exhibited a notable rise in potassium ion concentration at 6 hours after death.(Woharndee et al.,2020) According to the findings of the present study, there was a consistent and progressive decrease in postmortem glucose levels observed in both the vitreous humor and synovial fluid with direct proportion to the postmortem interval. This result consistent with the study noted that vitreous glucose concentrations exhibited a distinct pattern with a substantial hourly decrease of 35-70% within the first 6 hours after death at room temperature. This notable reduction highlights glucose as a potential marker for post-mortem investigations.(Pigaiani et al.,2020)

In the current study, it was observed that there is a continuous increase in potassium levels in the synovial fluid following death. The statistical analysis revealed a linear increase with a correlation coefficient of 0.735 and a highly significant p-value of <0.001*. Univariate regression analysis was performed, resulting in the estimation of an equation (T=6.873+5.657×K) to estimate the postmortem interval (T) based on the potassium level in the synovial fluid. These findings are consistent with the study conducted by (Arikeri et al.,2013) , which reported similar results regarding predicting postmortem interval from an equation .
Also these results agree with the study noted that postmortem interval and K+ have a strong positive correlation (r=0.978) in synovial fluid.(Aatiqa et al.,2022)
These findings highlight the significance of potassium analysis in the synovial fluid as a potential indicator for estimating the time since death in forensic investigations, supported by the consistency between the current study and prior research.

The findings of the current study indicate a consistent and continuous increase in potassium levels in the vitreous humor following death. The statistical analysis revealed a strong positive relation with a correlation coefficient of 0.754 and a highly significant p-value of 0.000. To further explore this relationship, univariate regression analysis was performed, resulting in the estimation of an equation (T=7.369+5.701×K). This equation allows for the estimation of the postmortem interval (T) based on the potassium level in the vitreous humor. These results highlight the utility of potassium analysis in the vitreous humor as a potential indicator for determining the time since death in forensic investigations.
These findings are consistent with a study conducted on 74 cases with postmortem intervals (PMI) ranging from 0 to 120 hours. In this study, vitreous humor was collected and analyzed for potassium concentration. The results demonstrated a significant increase in potassium concentration in vitreous humor corresponding to longer PMI. The study proposed a formula for time since death (TSD)=(value of equation×potassium level)
TSD = (7.6905×k-45) (Madea et al., 2001).

This aligns with another study which reported univariate regression analysis on electrolyte concentrations in vitreous humor. It found a significant relationship between time since death (TSD) and potassium, represented by the equation TSD = (4.701×K-29.063) with a correlation coefficient (R) of 0.841.(Siddamsetty et al.,2013)

Furthermore, these results are in agreement with a study which noted a similar relationship with an R value of 0.985.(Chaudhary et al.,2007)

Similarly, other studies also reported comparable results with an R value of 0.731 and the equation T=6.41×k-46.25.(Mulla,2005, Brandi et al.,2017)

All these studies consistent with this study which noted that the coefficient of correlation between post-mortem interval and potassium concentration in vitreous humor was found to be 0.997 with linear rise throughout increasing PMI (Prince et al.,2021)
A separate study found a statistically significant correlation between the increase in potassium levels and the time since death. The study demonstrated a linear relationship, with sample I (0-12

hours) of right vitreous potassium showing a correlation coefficient of 0.580, sample I (0-12 hours) of left vitreous potassium showing a coefficient of 0.536, sample II (12-24 hours) of right vitreous potassium showing a coefficient of 0.611, and sample II (12-24 hours) of left vitreous potassium showing a coefficient of 0.581. These findings reinforce the value of analyzing potassium levels in the vitreous humor for estimating the postmortem interval (Angayarkanni ,2020).

Additionally, study noted that the potassium levels in the vitreous humor increased as the TSD increased was statistically significant with values 0.901, 0.943, and 0.872 at the 0.01 or two-tailed level).(Sruthi et al.,2023)
These results inconsistent with the study which noted that the potassium levels in the vitreous humor decreased as the TSD increased (T=2.7157×k-19.95) with R value 0.527 (Tumram et al.,2011)**.**

The present study revealed a linear decrease in glucose levels in the synovial fluid following death. The statistical analysis demonstrated a correlation coefficient of 0.867 and a highly significant p-value of 0.000, indicating a strong negative relationship. Through univariate regression analysis, an equation (T=34.205-0.290×GL) was derived to estimate the postmortem interval (T) based on the glucose level in the synovial fluid. These findings align with a previous study conducted by (Sheikh,2008).

Similar findings were observed regarding the synovial fluid, which is inherently protected from burn and atmospheric variations, making it a valuable source for estimating the postmortem interval. The synovial fluid's ability to withstand external factors and maintain its integrity allows for reliable analysis and assessment. This biofluid serves as a valuable tool in forensic investigations, providing insights into the progression of postmortem changes and assisting in the determination of the time since death. By analyzing the synovial fluid, forensic experts can contribute to the accurate estimation of the postmortem interval and enhance the understanding of the physiological processes occurring after death (Sheikh, 2007).

According to the findings of the current study, there was a consistent and linear decrease in glucose levels in the vitreous humor following death. The statistical analysis revealed a strong negative relation with a correlation coefficient of 0.879 and a highly significant p-value of 0.000. Univariate regression analysis was conducted to further investigate this relationship, resulting in the estimation of an equation (T=34.429-0.290×GL). This equation allows for the estimation of the postmortem interval (T) based on the glucose level in the vitreous humor. These results emphasize the significance of glucose analysis in the vitreous humor as a potential marker for estimating the time since death in forensic investigations.

These findings consistent with the study which found increase of the postmortem interval, the glucose concentrations decline to zero in both synovial fluid and vitreous humor. The regression equation for glucose in synovial fluid 1.46 mg/dl-0.01*hpm and for glucose in vitreous humor 1.13mg/dl-0.01*hpm.(hpm= hours postmortem) (Madea et al.,2001).

Also in agreement with another study which reported a univariate regression analysis of electrolyte concentrations of vitreous humour showed weak relationship between TSD and glucose (R=0.241)TSD=47.856-0.382×GL (Siddamsetty et al.,2013).

Additionally, this coincide with study

that found regression equation of glucose level in vitreous equal (0.7345×GL-19.32)(Tumram et al.,2011). Also study which noted that vitreous glucose may be a useful marker in the estimates of postmortem interval (Clivia et al.,2018).

Postmortem alterations in biochemical electrolytes, particularly potassium, predominantly arise from anaerobic glycolysis. This process leads to the loss of active membrane transport and selective membrane permeability, facilitating the passive diffusion of electrolytes across various body compartments based on their concentration gradients. Notably, autolysis occurs faster in blood compared to cerebrospinal fluid (CSF), and even more gradually in synovial fluid and vitreous humor due to their enhanced preservation. Consequently, these latter fluids are preferred for assessing late postmortem chemical changes in order to determine the postmortem interval (PMI).(Aatiqa et al.,2022)

Vitreous humor and synovial fluid stand out as crucial body fluids in forensic pathology, offering valuable insights into determining the cause and manner of death. These fluids serve as informative sources for detecting the presence of drugs, alcohol, and unidentified substances, as well as aiding in disease diagnosis. Additionally, their potential extends to genomic analysis. Future research endeavors could prioritize refining methodologies for accurately estimating post-mortem intervals, enhancing the specificity of drug and alcohol detection, and innovating techniques for identifying unknown substances. The exploration of these fluids' diagnostic capabilities for diseases and their potential in genomic analysis presents a promising avenue for further investigation and advancement in forensic pathology.(Rangaiah et al.,2023)

V.Conclusion

Biochemical analysis of potassium and glucose levels in aspirated vitreous humor and synovial fluid can assist in estimating the postmortem period. By utilizing univareate regression analysis, correlations between these biochemical markers and the time since death can be established, allowing for a quantitative estimation. This approach provides valuable insights and evidence in forensic investigations, aiding in determining the postmortem interval and enhancing the understanding of the physiological changes after death.

VI.Study limitations

To achieve this study, we need to apply two methods (synovial fluid and vitreous humor). Because of that we are applying them into the same corpse, the required inclusion-exclusion criteria imply items that affect both methods. This might seem a limitation in our study in terms of the sample size. However, the major proportion of the corpses are going to be cases that end up dying at the hospital and came to mortuary which are the ones that with a very high probability will meet the criteria in order to be part of this project. Also, to perform analysis of all electrolytes it need more fund.

VII.List of Abbreviations

PMI	Postmortem Interval
K	potassium
GL	Glucose level
T	postmortem interval
R	Correlation

VIII.Consent for publication

I confirm that all authors have approved the manuscript for submission and publication.

IX.Competing interests

We have no competing interests to disclose.

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XI.Authors' contributions

All authors contributed equally in the study.

XII. Acknowledgments

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XIII.References

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الملخص العربي

تقدير فترة ما بعد الوفاة من خلال قياس البوتاسيوم و الجلوكوز في السائل الزلالي و السائل الزجاجي

أمل رؤوف صالح، محمد جمعه مخلوف
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المقدمة وهدف الدراسة: مكن تقدير الوقت الذي ينقضي بعد وفاة الفرد من خلال ملاحظة بعض الأحداث و التغيرات التي تحدث في الجثة بعد توقف الحياة. أحد هذه التغييرات ينطوي على التغيرات البيوكيميائية في مكونات السائل الزجاجي والسائل الزلالي.

ويمكن التعرف على هذه التغيرات عن طريق إجراء التحليل الكيميائي على هذه السوائل ونظرًا للفصل المتميز لهذه السوائل داخل تجاويف كل منها، فهي مناسبة للتحليل الكيميائي دون أن تتأثر بالعوامل أو المخاطرالخارجية. ويهدف هذا البحث إلى توفير طريقة موثوقة لتقدير وقت الوفاة بناء على التغيرات البيوكيميائية في هذه السوائل ،مما يساهم في تحقيقات الطب الشرعي و علم الطب الشرعي بشكل عام.

طرق البحث: يستخدم هذا العمل التحليل الكيميائي لاكتشاف ودراسة التغيرات البيوكيميائية التي تحدث في هذه السوائل على فترات 8،16، و24 ساعة بعد الوفاة. ومن خلال فحص مستويات البوتاسيوم والجلوكوز في كل تجويف، يمكن للباحثين تقدير فترة ما بعد الوفاة، والتي تشير إلى الوقت الذي انقضى منذ وفاة الشخص.

النتائج: شملت الدراسة الحالية فحص 53 فرداً متوفين تعرضوا لحوادث سيارات. تم جمع العينات من تجاويف الجسم الزجاجي والركبة، على فترات 8،16،24 ساعة بعد وقوع الحوادث. ثم تم إخضاع هذه العينات للتحليل لتحديد مستويات البوتاسيوم والجلوكوز. ووفقا لنتائج الدراسة، كانت هناك زيادة ذات دلالة إحصائية وثابتة في مستويات البوتاسيوم، إلى جانب انخفاض تدريجي في مستوى الجلوكوز لوحظ في كل من السائل الزجاجي والسائل الزلالي، والذي كان يتناسب طرديا مع الزيادة في فترات زمنية.

ملخص البحث: كان تحليل البوتاسيوم والجلوكوز للسائل الزجاجي والسائل الزلالي أداة قيمة لتقد ير فترة ما بعد الوفاة.