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Research Article

Effect of Time and Haemolysis on Prothrombin Time (PT) and Activated Partial Thromboplastin Time (APTT) Measurement on Blood Samples

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Abstract

Background: Coagulation, also known as blood clotting, is the process by which blood convert from a liquid to a gel, forming a blood clot. It referred to haemostasis, the stopping of blood loss from a damaged vessel, followed by repair.

Material and methods: This was cross sectional study conducted at the albawasla medical laboratory, Khartoum, Sudan during the period August to November, 2021 and to evaluate the effect of time and hemolysis on prothrombin time and activated partial thromboplastin time tests. 50 samples (case group) were collected from the patients attending police teaching hospital and requested to the PT and APTT test in addition to that,50 apparently healthy donors with no history of any coagulation problems or any chronic disease were selected as control group. Three ml of venous blood samples were collected in container with Tri Sodium Citrate anticoagulant. The coagulation tests (PT and APTT) were performed using semiautomatic device (coagulometer machine MI).

Results: The result of this study revealed that; when compared the measurement of PT and APTT immediately and after one hour there was insignificant differences (p. v.>0.05). also when compared the measurement of PT and APTT between hemolyzed and non-hemolyzed samples there was significant differences (p. v.<0.05) in addition when compared case and control for the PT and APTT immediately, after one hour, hemolyzed and non-hemolyzed sample there was significant differences (p. v.<0.05) except the APTT hemolyzed samples and insignificant differences with age and gender (p. v.>0.05). For the correlation there was significant correlation in the case group for the PT and APTT immediately, after one hour, and hemolyzed samples.

Conclusion: In the cases group results showed insignificant differences in the results of PT and APTT between immediate sample and after 1 hour in and significant differences in the results of PT and APTT between hemolyzed and non-hemolyzed samples, also there was insignificant differences between age and gender, immediately, after one hr. and hemolyzed sample in PT and APTT.

Keywords: Homeostasis, hemolyzed sample, PT and APTT

1 INTRODUCTION

Coagulation, also known as blood clotting, is the process by which blood convert from a liquid to a gel, forming a blood clot. It referred to haemostasis, the stopping of blood loss from a damaged vessel, followed by repair. The mechanism of coagulation involves activation, adhesion and aggregation of platelets, and formation of fibrin [1]

Coagulation begins almost immediately after an injury to the endothelium lining a blood vessel. Exposure of blood to the subendothelial space initiates two processes: changes in platelets, and the exposure of subendothelial tissue factor to plasma factor VII, which finally leads to cross-linked fibrin formation. Platelets immediately form a plug at the site of injury; this is called primary haemostasis. Secondary haemostasis occurs at the same time: additional coagulation (clotting) factors together factor VII (listed below) respond in a cascade to form fibrin strands which strengthen the platelet plug.[1]

Numerous tests are used to assess the function of the coagulation system commonly: APTT, PT (also used to determine INR), fibrinogen testing (often by the Clauss method), platelet count, platelet function testing (often by PFA-100), thrombi dynamic test. The contact activation (intrinsic) pathway is initiated by activation of the "contact factors" of plasma, and can be measured by the activated

partial thromboplastin time (APTT) test. The tissue factor (extrinsic) pathway is initiated by release of tissue factor (a specific cellular lipoprotein), and can be measured by the prothrombin time (PT) test. PT results are often reported as ratio (INR value) to monitor dosing of oral anticoagulants such as warfarin. The quantitative and qualitative screening of fibrinogen is measured by the thrombin clotting time (TCT). Measurement of the exact amount of fibrinogen present in the blood is generally done using the Clauss method for fibrinogen testing.

Many analyzers are capable of measuring a "derived fibrinogen" level from the graph of the Prothrombin time clot. If a coagulation factor is part of the contact activation or tissue factor pathway, a deficiency of that factor will affect only one of the tests: Thus, hemophilia A, a deficiency of factor VIII, which is part of the contact activation pathway, results in an abnormally prolonged APTT test but a normal PT test. The exceptions are prothrombin, fibrinogen, and some variants of FX that can be detected only by either APTT or PT. If an abnormal PT or APTT is present, additional testing will occur to determine which (if any) factor is present as aberrant concentrations. Deficiencies of fibrinogen (quantitative or qualitative) will affect all screening tests. [2]

PT and APTT were clinically stable if the percent (%) value of change was within 5 %. the data demonstrated that PT results of plasma was stable for up to 24hrs regardless of storage temperature and at both 4 degrees C and -20 degrees C stable for up to 48 hrs. PT results of whole blood were stable for up to 24 hrs at room temperature while at 4 degrees C the stability was less than 4hrs. On the other hand, APTT of plasma was stable for up to 8 hrs either at room temperature or at 4 degrees C while for up to 48 hrs stable in freezing condition. Interestingly that APTT stability of whole blood was no more than 4 hrs.

The destruction of red blood cells which leads to the release of haemoglobin into the blood plasma. Receiving haemolytic specimens for laboratory tests is a common phenomenon in many of the clinical laboratories and it is one of the important factors that affect pre-analytical errors in many of these laboratories. [3,4,5,6,7,8]

Collection of blood is a first step in good quality of reporting in coagulation studies. In coagulation assays rejection of haemolyzed samples is commonly recommended by testing device manufacturers and accrediting organizations.[14] Rejections of these samples create significant delays in the treatment and disposition of patients in the emergency department. The additional cost is incurred per-collected specimen, adding to the overall cost of laboratory operation. The true impact of haemolysis on coagulation studies is little studied in clinical practice. [4.] According to the Clinical and Laboratory Standard Institute (CLSI), blood samples that show apparent hemolysis may undergo premature coagulation activity and also disrupt the clot detection by the optical instruments. Hemolysis is the most common reason why coagulation test samples are rejected. However, the effects of hemolysis on prothrombin time (PT) and activated partial thromboplastin time (APTT) are rarely investigated and the results are controversial. The consequence of hemolyzed blood sample rejection is repeat blood sample collection that causes additional discomfort to patients, delayed test results, and increased laboratory operating costs. This study aimed to evaluate the effect of time and hemolysis on prothrombin time and activated partial thromboplastin time tests.

MATERIAL AND METHODS

This was cross sectional study conducted at the albawasla medical laboratory, Khartoum, Sudan during the period August to November, 2021 and to evaluate the effect of time and hemolysis on prothrombin time and activated partial thromboplastin time tests. Patients attending police teaching hospital and requested to the PT APTT test during the aforementioned period were included. In addition to that, apparently healthy donors with no history of any coagulation problems or any chronic disease were selected as control group. Non hemolyzed sample (from the first time of collection), and samples that delayed more than one hour, also samples collected from the donor under coagulant treatment were excluded **.** Three ml of venous blood samples were collected in container with Tri Sodium Citrate anticoagulant. The coagulation tests (PT and APTT) were performed using semiautomatic device (coagulometer machine MI).

SPSS16.0 statistical software (SPSS Inc., USA) was used for statistical analysis. Data was expressed as means with standard deviations (SD). The statistical analysis was performed by the analysis of variance. A value of P <0.05 was Considered statistically significant**.** This study was approved by the ethical committee of national university. A written informed consent was obtained from all participants before sample collection.

RESULTS

The epidemiological study

In the present study among case group 46% were males and 54% were females also in control group 46 % were males and 54 % were females(Table1) (figure 1,2). According to age group there was29 < 30 years and 21≥ 30 years in the case group, in the control group there was 31 < 30 years and 19 ≥30 (Table 2, 3).

Table (1) Frequency of gender in case and control

Gender		Frequency	Percent
Case	Male	23	46.0
	Female	27	54.0
	Total	50	100.0
Control	Male	23	46.0
	Female	27	54.0
	Total	50	100.0

Table (2) Descriptive Statistics of age of case and control

	N	Minimum	Maximum	Mean	Std. Deviation
Case					
Age (years)	50	18	57	31.1	11.3
Control					
Age (years)	50	16	56	30.3	11.8

Table (3) Frequency of age on case and control

Age		Frequency	Percent
Case	< 30 years	29	58.0
	≥ 30 years	21	42.0
	Total	50	100.0
Control	< 30 years	31	62.0
	≥ 30 years	19	38.0
	Total	50	100.0

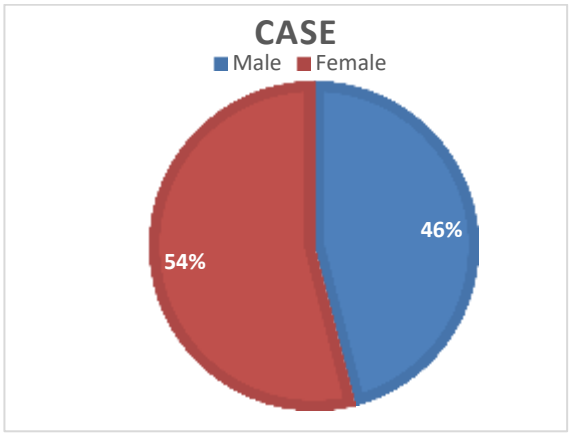

Figure (1): Frequency of gender in case

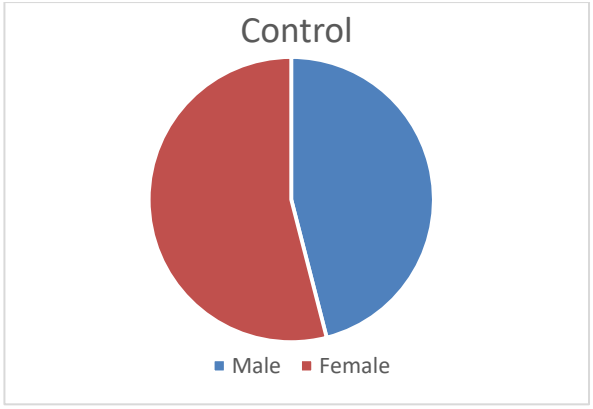

Figure (2) Shows Frequency of gender in control

Hematological results

The result of this study revealed that; when the PT was measured immediately the minimum result (17.0sec) and maximum result (75.6 sec) mean (26.9), and when measured after one hour the minimum result (17.5 sec) and maximum result (75.0 sec) mean (27.1). In the control group when the PT measured immediately the minimum result (12.9sec) and maximum result (19.5 sec) mean (15.9), and after one hour the minimum result (13.2 sec) and maximum result (19.8 sec) mean (16.2) (table 4).However, when compared the measurement of PT immediately and after one hour there was insignificant differences (p. v.>0.05) (table 5)

For the APTT in the case group when measured immediately the minimum result (22.4sec) and maximum result (95.0 sec) mean (47.5), after one hour the minimum result (22.5 sec) and maximum result (96.5sec) mean (47.8) (table 4). In the control group APPT was measured immediately the minimum result (21.sec) and maximum result (37.0 sec) mean (28.3), when measured after one hour the minimum result (22.5 sec) and maximum result (38.6 sec) mean (29.9) (table 6). In addition, when compared the measurement of APTT immediately and after one hour there was insignificant differences (p. v.>0.05) (table 5)

PT hemolyzed sample was measured the minimum result (13.5) and maximum result (30.4 sec) mean (16.9) furthermore non-hemolyzed sample also was measured; the minimum result (12.9sec) and maximum result (19.5 sec) mean (15.9) (table 4). When compared between hemolyzed and non-hemolyzed samples there was significant differences (p. v.<0.05) (table 7)

In the other hand APTT hemolyzed was measured the minimum result (31.4 sec) and maximum result (130.1 sec) mean (45.1) and non-hemolyzed sample also was measured the minimum result (21.0sec) and maximum result (37.6 sec) mean (28.6) When compared between hemolyzed and non-hemolyzed samples there was significant differences (p. v.<0.05) (table 7).

Generally, when compared case and control for the PT and APTT immediately, after one hour, hemolyzed and non-hemolyzed sample there was significant differences (p. v.<0.05) except the APTT hemolyzed samples (table 8,9) and in significant differences with age and gender (p. v.>0.05) (table 10,11,12,13). For the correlation the was significant correlation in the case group for the PT and APTT immediately, after one hour, andhemolyzed samples (table14)

Table (4) Descriptive Statistics of case parameters

Parameters	N	Minimum	Maximum	Mean	Std. Deviation
PT of Case					
Immediately	50	17.0	75.6	26.9	12.5
After one hr.	50	17.5	75.0	27.1	12.5
Hemolyzed sample	50	12.0	54.0	20.8	10.6
Non hemolyzed sample	50	17.0	75.6	26.9	12.5
APTT of Case					
Immediately	50	22.4	95.0	47.5	17.1
After one hr.	50	22.5	96.5	47.8	16.9
Hemolyzed sample	50	24.0	79.0	40.9	13.2
Non hemolyzed sample	50	22.4	95.0	47.5	17.1

Table (5) Compassion of PT and APTT between immediate sample and after 1 hr. in case

Parameters	Immediately (n=50)	After one hr.(n=50)	P. value
PT (Seconds)	26.9 ± 12.5	27.1 ± 12.5	0.954
APTT (Seconds)	47.5 ± 17.1	47.8 ± 16.9	0.931

Table (6) Descriptive Statistics of control parameters

Parameters	N	Minimum	Maximum	Mean	Std. Deviation
PT of Control					
Immediately	50	12.9	19.5	15.9	1.6
After one hr.	50	13.2	19.8	16.2	1.7
Hemolyzed sample	50	13.5	30.4	16.9	2.5
Non hemolyzed sample	50	12.9	19.5	15.9	1.6
APTT of Control					
Immediately	50	21.0	37.3	28.3	3.6
After one hr.	50	22.5	38.6	29.9	3.2
Hemolyzed sample	50	31.4	130.1	45.1	15.3
Non hemolyzed sample	50	21.0	37.6	28.6	3.8

Table (7) Compassion of PT and APTT between hemolyzed and non-hemolyzed sample in case

Parameters	Hemolyzed sample (n=50)	Non hemolyzed sample (n=50)	P. value
PT (Seconds)	20.8 ± 10.6	26.9 ± 12.5	0.009*
APTT (Seconds)	40.9 ± 13.2	47.5 ± 17.1	0.032*

Table (8) Compassion of PT between case and control

PT	Case (n=50)	Control (n=50)	P. value
Immediately	26.9 ± 12.5	15.9 ± 1.6	0.000*
After one hr.	27.1 ± 12.5	16.2 ± 1.7	0.000*
Hemolyzed sample	20.8 ± 10.6	16.9 ± 2.5	0.014*
Non hemolyzed sample	26.9 ± 12.5	15.9 ± 1.6	0.000*

Table (9) Compassion of APTT between case and control

APTT	Case (n=50)	Control (n=50)	P. value
Immediately	47.5 ± 17.1	28.3 ± 3.6	0.000*
After one hr.	47.8 ± 16.9	29.9 ± 3.2	0.000*
Hemolyzed sample	40.9 ± 13.2	45.1 ± 15.3	0.139
Non hemolyzed sample	47.5 ± 17.1	28.6 ± 3.8	0.000*

Table (10) Compassion of PT according to gender of case

PT	Gender		P. value
	Male (n=23)	Female (n=27)	
Immediately	27.7 ± 15.6	26.3 ± 9.5	0.710
After one hr.	27.5 ± 15.4	26.7 ± 9.7	0.824
Hemolyzed sample	22.2 ± 13.1	19.6 ± 7.9	0.382
Non hemolyzed sample	27.7 ± 15.6	26.3 ± 9.5	0.710

Table (11) Compassion of APTT according to gender of case

APTT	Gender		P. value
	Male (n=23)	Female (n=27)	
Immediately	50.1 ± 18.3	45.3 ± 15.9	0.330
After one hr.	50.6 ± 17.7	45.4 ± 16.2	0.278
Hemolyzed sample	40.7 ± 14.1	40.9 ± 12.6	0.941
Non hemolyzed sample	50.1 ± 18.3	45.3 ± 15.9	0.330

Table (12) Compassion of PT according to age of case

PT	Age		P. value
	< 30 years	≥ 30 years	
Immediately	28.9 ± 15.8	24.3 ± 4.6	0.204
After one hr.	29.2 ± 15.8	24.2 ± 4.6	0.172
Hemolyzed sample	22.4 ± 13.3	18.5 ± 4.4	0.205
Non hemolyzed sample	28.9 ± 15.8	24.3 ± 4.6	0.204

Table (13) Compassion of APTT according to age of case

APTT	Age		P. value
	< 30 years	≥ 30 years	
Immediately	47.8 ± 19.4	47.0 ± 13.6	0.869
After one hr.	48.4 ± 19.1	47.0 ± 13.8	0.789
Hemolyzed sample	40.0 ± 15.2	42.0 ± 10.0	0.605
Non hemolyzed sample	47.8 ± 19.4	47.0 ± 13.6	0.869

Table (14) Correlations in between immediately, after one hr. and hemolyzed sample in PT and APTT in case

			After one hr.	Hemolyzed sample
PT	**Immediately**	Pearson Correlation	.997*	.797*
		P. value	.000	.000
		N	50	50
APTT	**Immediately**	Pearson Correlation	.997*	.864*
		P. value	.000	.000
		N	50	50

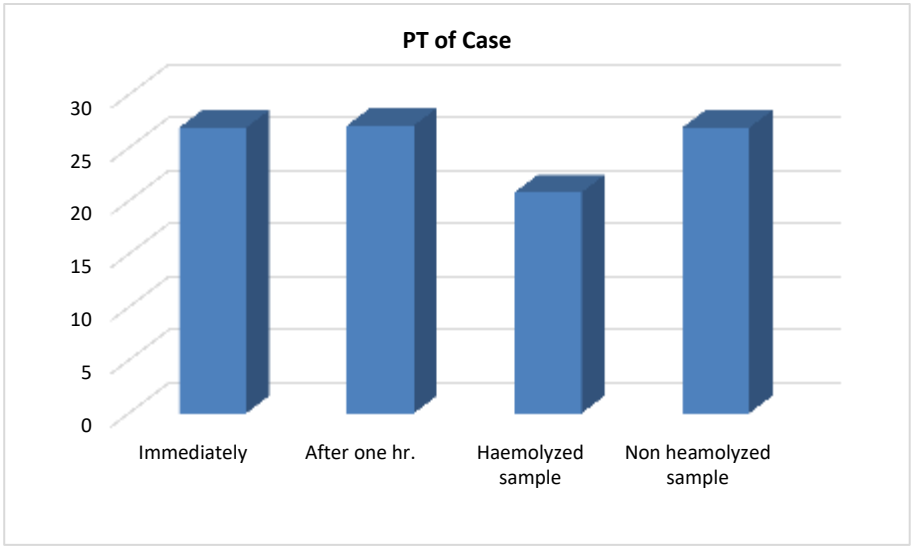

Figure (3): PT of case group

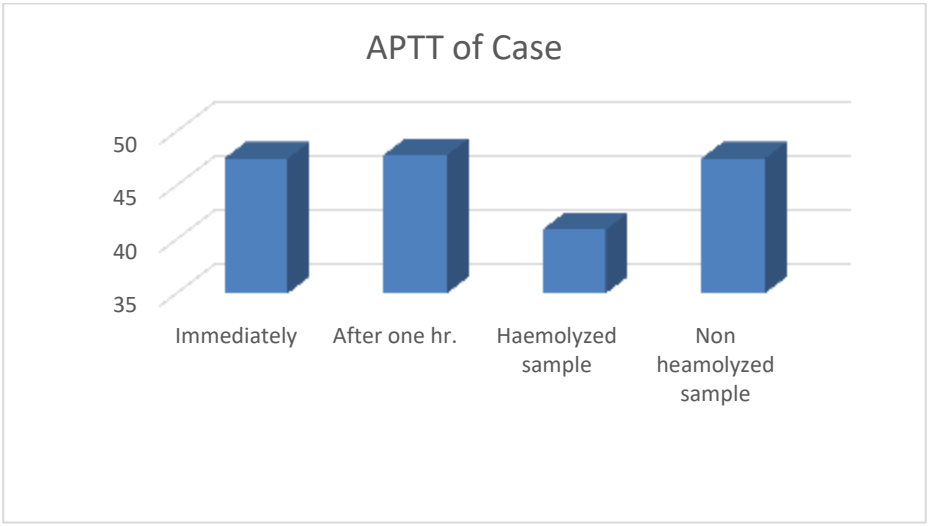

Figure (4): APPT of case group

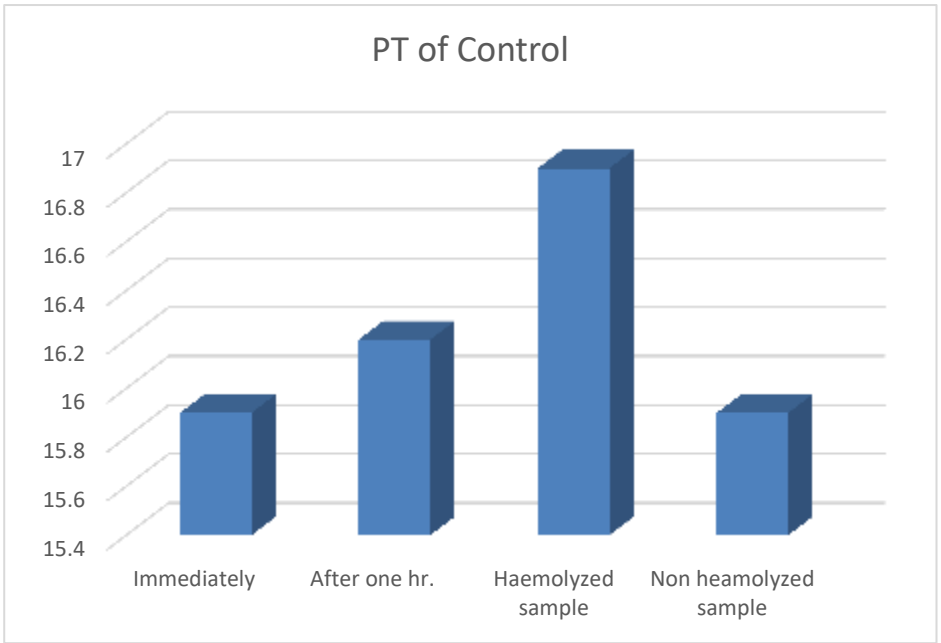

Figure (5): PT of control group

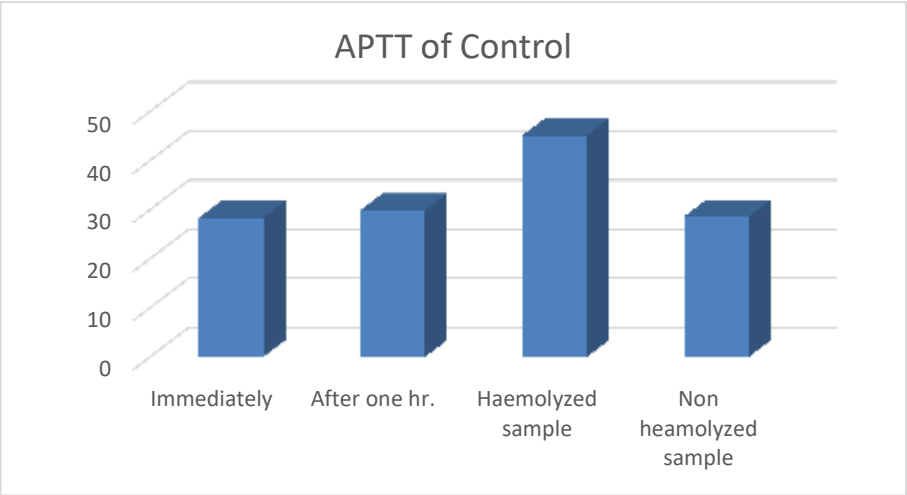

Figure (6): APPT of control group

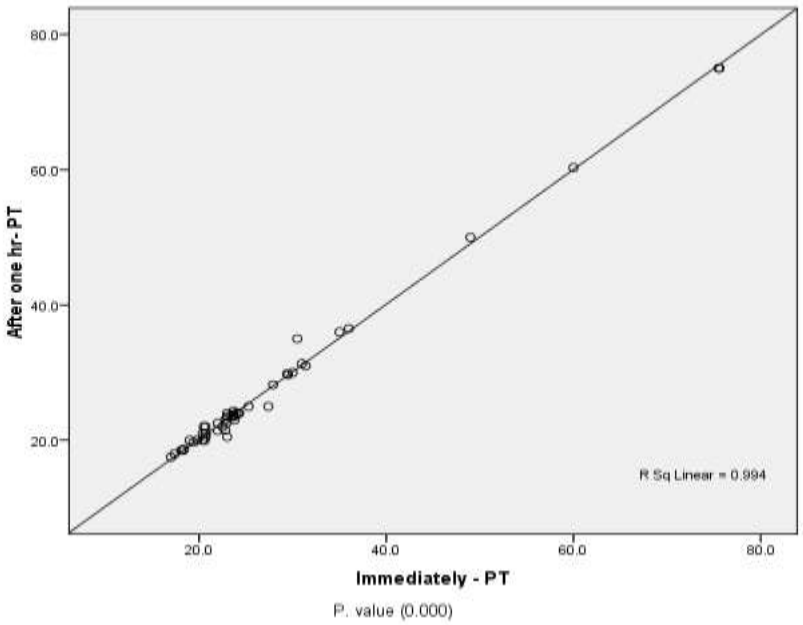

Figure (7): Correlations between immediately and after one hr. in PT results

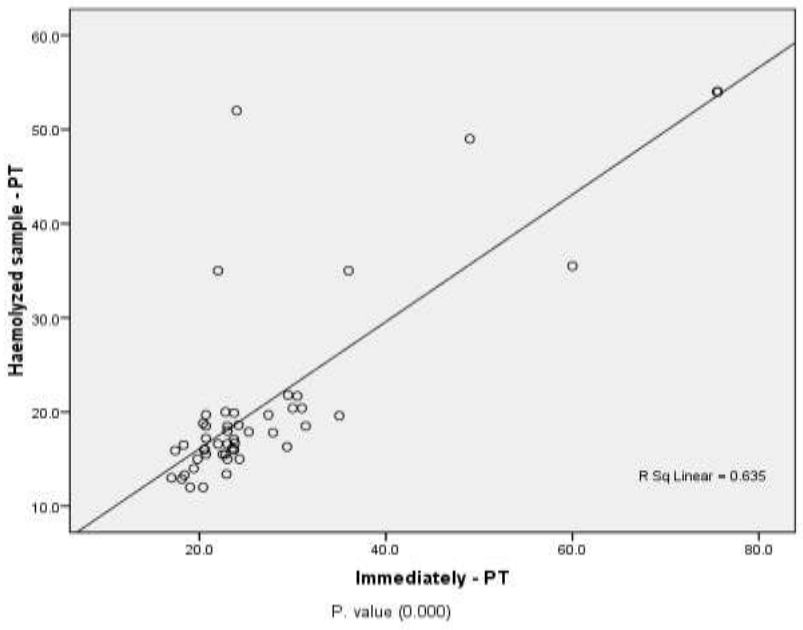

Figure (8): Correlations between immediately and hemolyzed sample in PT results

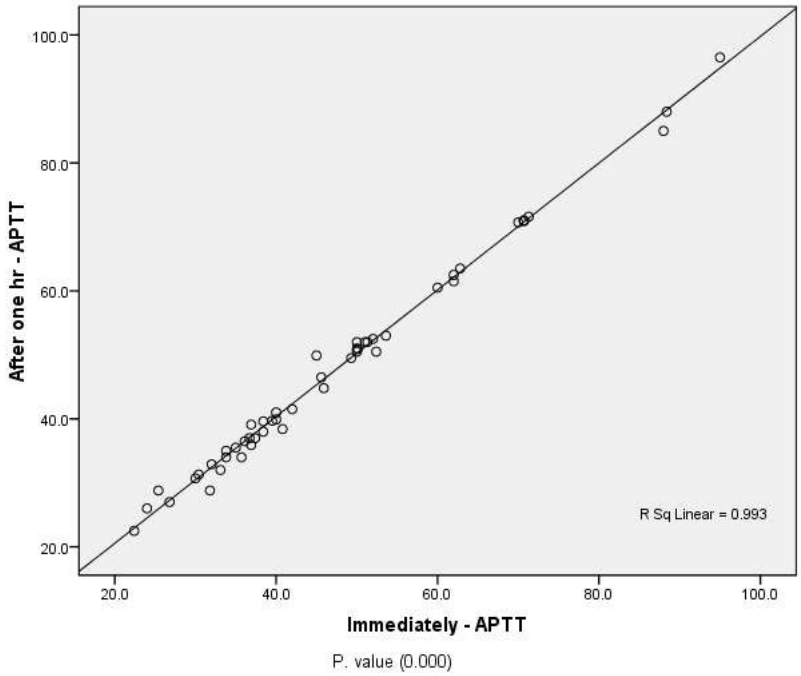

Figure (9): Correlations between immediately and After one hr. in APTT results

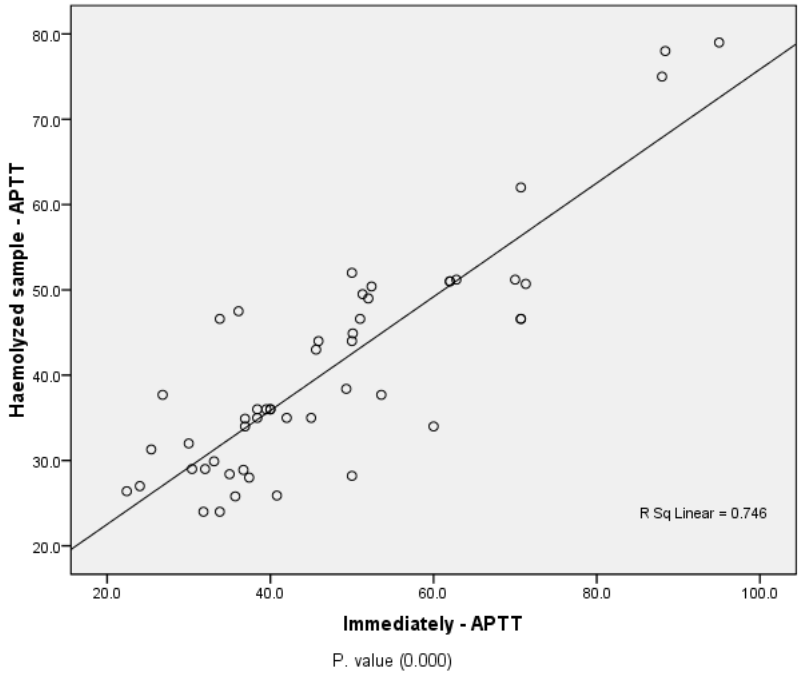

Figure (10): Correlations between immediately and hemolyzed sample in APTT results

DISCUSSION

Pre-analytical and analytical variables including storage temperature and time interval between sample collection and testing can have a significant effect of results of hemostatic laboratory testing [9] ,Pre-analytical variables including specimen collection, storage, temperature, transport, anticoagulant type, hematocrit, filling status of the sampling tube and centrifugation variable can potentially affect analysis results and by extension the medical care offered to patients[10], This study evaluated the effect of time and hemolysis on prothrombin time and activated partial thromboplastin time tests.

The result of this study revealed that; when the PT was measured immediately the minimum result (17.0sec) and maximum result (75.6 sec) mean (26.9), and when measured after one hour the minimum result (17.5 sec) and maximum result (75.0 sec) mean (27.1). In the control group when the PT measured immediately the minimum result (12.9sec) and maximum result (19.5 sec) mean (15.9), and after one hour the minimum result (13.2 sec) and maximum result (19.8sec) mean (16.2) (table 4).However, when compared the measurement of PT immediately and after one hour there was insignificant differences (p. v.>0.05).This result was similar with study conducted by Usman et al which revealed insignificant differences for the PT and APTT immediately and after one hour [9]

For the APTT in the case group when measured immediately the minimum result (22.4sec) and maximum result (95.0 sec) mean (47.5), after one hour the minimum result (22.5 sec) and maximum result (96.5sec) mean (47.8) (table 4). In the control group APPT was measured immediately the minimum result (21.sec) and maximum result (37.0 sec) mean (28.3), when measured after one hour the minimum result (22.5 sec) and maximum result (38.6sec) mean (29.9) (table 6). In addition, when compared the measurement of APTT immediately and after one hour there was insignificant differences (p. v.>0.05)

One of study reported; The PT test was not easily affected by the temperature, storage time and the form of storage in comparison with the APTT test which was much easily affected by the above conditions. APTT should be done within 8 hours after blood was centrifuged immediately and the plasma should be stored freezing in order to obtain a reliable result.[10]

The result of PT hemolyzed sample was measured the minimum result (13.5) and maximum result (30.4 sec) mean (16.9) furthermore non-hemolyzed sample also was measured; the minimum result (12.9sec) and maximum result (19.5 sec) mean (15.9) (table 4). When compared between hemolyzed and non-hemolyzed samples there was significant differences (p. v.<0.05)

In the other hand APTT hemolyzed was measured the minimum result (31.4 sec) and maximum result (130.1 sec) mean (45.1) and non-hemolyzed sample also was measured the minimum result (21.0sec) and maximum result (37.6 sec) mean (28.6) When compared between hemolyzed and non-hemolyzed samples there was significant differences (p. v.<0.05). Alvaro C. said; hemolysis is a common finding in specimens sent to clinical laboratory for various tests, which includes coagulation testing also. The relative prevalence of hemolyzed specimens described in literature is as high as 3.3% of all of the sample's afferent to a clinical laboratory. Hemolysis is clearly visible in specimens containing as low as 0.5% hemolysate [11]. The clinical and Laboratory Standards Institute, in its guidelines for prothrombin time (PT) and activated partial thromboplastin time (APTT) testing, states that samples with visible haemolysis should not be used because of possible clotting factor activation and interference with end point measurement interference.[12]

Conversely, in vitro blood cell lysis might be prevented, because it is usually caused by inappropriate specimen collection, handling and processing. In the case of specimen collection, hemolysis might result from traumatic specimen collection and processing, such as unsatisfactory phlebotomy attempts, difficulty in locating venous accesses, application of tourniquet for prolonged time, wet-alcohol transfer from the skin into the blood specimen, small or fragile veins, small-gauge needles, vigorous tube mixing and shaking or exposure to excessively hot **or** cold temperatures.[13]

Finally, when compared case and control for the PT and APTT immediately, after one hour, hemolyzed and non-hemolyzed sample there was significant differences (p. v.<0.05) except the APTT hemolyzed samples and in significant differences with age and gender (p. v.>0.05). For the correlation thewas significant correlation in the case group for the PT and APTT immediately, after one hour, and hemolyzed samples.

CONCLUSION

In the conclusion The result showed insignificant differences in the reading of PT and APTT between immediate sample and after 1 hour in case group and show statistically significant differences in the reading of PT and APTT between hemolyzed and non-hemolyzed sample in case group , also there was in significant differences between age and gender , immediately, after one hr. and hemolyzed sample in PT and APTT in case group. Another study with larger sample size should be conducted to control the interference of other factors, also is the most important to consider the time and collection methods for the coagulation samples, and any hemolyzed and delayed samples should be rejected.

REFERENCES:

1-Furie B, Furie BC. "Thrombus formation in vivo". The Journal of Clinical Investigation. 2005; 115(12):3355-62. PMC 1297262. PMID 16322780. https://doi.org/10.1172/JCI26987

2- David Lillicrap; Nigel Key; Michael Makris; Denise O'Shaughnessy Practical Haemostasis and Thrombosis. Wiley-Blackwell.2009. pp. 1-5. ISBN 978-1-4051-8460-1.

3-Chawla R, Goswami B, Singh B, Chawla A, Gupta VK, Mallika V. Evaluating laboratory performance with quality indicators. Lab Med. 2010; 41:297-300. https://doi.org/10.1309/LMS2CBXBA6Y0OWMG

4. Laga AC, Cheves TA, Sweeney JD. The effect of specimen haemolysis on coagulation test results. Am J Clin Pathol. 2006; 126:748-55. https://doi.org/10.1309/03FK3378YTRA1FRF

5. Lippi G, Guidi GC. Effect of specimen collection on routine coagulation assays and D-dimer measurement. Clin Chem. 2004; 50:2150-2. https://doi.org/10.1373/clinchem.2004.036244

6. Bauer NB, Eralp O, Moritz A. Effect of haemolysis on canine kaolin-activated thromboelastography values and ADVIA 2120 platelet activation indices. Vet Clin Pathol. 2010; 39:180-9. https://doi.org/10.1111/j.1939-165X.2010.00224.x

7. Marlar RA, Potts RM, Marlar AA. Effect on routine and special coagulation testing values of citrate anticoagulant adjustment in patients with high hematocrit values. Am J Clin Pathol. 2006; 126:400-5. https://doi.org/10.1309/RRQKT2JEYV33D19D

8. van Geest-Daalderop JH, Mulder AB, Boonman-de Winter LJ, Hoekstra MM, van den Besselaar AM. Preanalytical variables and off-site blood collection: Influences on the results of the prothrombin time/international normalized ratio test and implications for monitoring of oral anticoagulant therapy. Clin Chem. 2005; 51:561-8. https://doi.org/10.1373/clinchem.2004.043174

9. Lippi, G., Guidi, G.C., Mattiuzzi, C. and Plebani, Preanalytical Variability: The Dark Side of the Moon in Laboratory Testing. Clinical Chemistry and Laboratory Medicine, 2006; 44:358-365. https://doi.org/10.1515/CCLM.2006.073

10. Zhao, Y. and Lv, G. Influence of Temperature and Storage Duration on Measurement of Activated Partial Thromboplastin Time, D-Dimers, Fibrinogen, Prothrombin Time and Thrombin Time, in Citrate-Anticoagulated Whole Blood Specimens. International Journal of Laboratory Haematology, 2013; 35:566-570. https://doi.org/10.1111/ijlh.12113

11. Burns ER, Yoshikawa N. Homolysis in serum samples drawn by emergency department personnel versus laboratory phlebotomists. Lab Med. 2002; 33:378-80. https://doi.org/10.1309/PGM4-4F8L-2P1M-LKPB

12.Favaloro EJ, Funk DM, Lippi G. Pre-analytical variables in coagulation testing associated with diagnostic errors in haemostasis. Lab Med 2012; 43:1-0 https://doi.org/10.1309/LM749BQETKYPYPVM

13. Kroll MH, Elin RJ. Interference with clinical laboratory analyses. Clin Chem. 1994; 40:1996-2005. https://doi.org/10.1093/clinchem/40.11.1996