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Variations in activated partial thromboplastin time and prothrombin time in individuals of A, B, AB, and O blood groups

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Abstract:

BACKGROUND: Differences in blood group have been associated with predisposition to some diseases. Activated partial thromboplastin time (APTT) measures the efficiency of the intrinsic and common coagulation pathways, whereas prothrombin time (PT) test assesses the extrinsic and common coagulation pathways.

OBJECTIVE: The aim of this study was to assess the variations in PT and APTT among individuals of different ABO blood groups.

MATERIALS AND METHODS: A research was conducted at College of Health Sciences, Nnamdi Azikiwe University, Nnewi Campus, and a total of 200 students were recruited, consisting of 106 females and 94 males. Six milliliters of blood was withdrawn from each individual, after obtaining ethical clearance and informed consent. ABO blood grouping was done by the tile method while APTT, and PT were analyzed using the standard manual methods. Statistical analysis was carried out using Statistical Package for the Social Sciences version 21.

RESULTS: The result shows that blood group O was predominant among the test individuals (45%) followed by blood groups A (31%) and B (15%), while blood group AB has the least percentage (9%). Blood group O showed a significantly higher APTT value (44.24 ± 15.10 s) compared to blood groups A (39.35 ± 12.12 s), B (35.93 ± 9.78 s), and AB (37.22 ± 8.15 s) ($P < 0.05$). Similarly, blood group A showed a significantly higher PT value (16.70 ± 2.53 s) compared to blood groups O (14.32 ± 2.37 s), B (13.53 ± 2.16 s), and AB (15.38 ± 1.79 s) ($P = 0.05$). Blood groups B and AB male individuals had a significantly higher PT and APTT levels, respectively, when compared with females ($P < 0.05$).

CONCLUSION: This study showed that APTT and PT levels differ among different ABO blood groups; therefore, variations in blood group of individuals may affect their intrinsic and extrinsic coagulation mechanisms.

Keywords:

ABO blood group, activated partial thromboplastin time, prothrombin time

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Introduction

Before ABO blood groups were discovered, lack of knowledge of the differences in blood composition observed between animals and humans and within the human population resulted in high rates of mortality.[1] Blood group variations are of major clinical and medicolegal importance. Even though there are many blood group systems, the ABO blood group is of great clinical importance. ABO blood group system was discovered by Karl Landsteiner and also identified the O, A, and B blood group types in 1900 which served as the beginning of blood banking and transfusion medicine;[2]

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Alfred von Decastello and Adriano Sturli discovered the AB blood group in 1902. The antigenic property of red blood cells forms the basis for ABO blood grouping.

The surface membrane of red blood cells contains antigens as complex oligosaccharides with different terminal sugar and their genes are located on the chromosome.[3] The A, B, and H antigens are complex carbohydrate molecule found on the extracellular surface of red blood cell membrane.[4] These A and B antigens differ in their terminal sugar, and the location of gene coding for these antigens is on chromosomes 9 and 19.[5] These antigens are inherited as Mendelian dominants.

The clinical significance of the ABO blood group extends beyond immunohematology and transfusion medicine. The alterations in the major antigens of the ABO blood group, which are usually present on the surface of red blood cells and different epithelial cells, have revealed associations between ABO blood groups and disease,[6] the most important being represented by infections and cardiovascular disorders,[7,8] and show an important involvement in the development of oncological and other diseases.[7,9] Blood group type has been known to predispose individuals to certain diseases. This is supported by various research findings that have shown association of diseases such as gastric carcinoma, duodenal ulcer, peptic ulcers, diabetes mellitus, bleeding, malignancy, venous thrombosis, and urinary tract infection with ABO blood group types.[10-12]

About a dozen of coagulation factors have been identified in the blood. These coagulation factors are known to be proteins that exist in the blood in an inactive state but are activated when tissues or blood vessels are damaged.[13] Activated partial thromboplastin time (APTT) and prothrombin time (PT) are indices that give an insight into the coagulation status of individuals. They are common clinical tests used to screen generally for coagulation factor deficiencies.[14,15]

PT detects disorders of the extrinsic and common coagulation pathways. Abnormal result is usually seen when factor I (FI), FII, FV, FVII, and FX are deficient[16] while the APTT screens for abnormalities of the intrinsic and common coagulation pathways. It monitors the activities of FI, FII, FV, FVIII, FIX, FX, FXI, and FXII.[17] ABO blood group and gender are dependent variations in APTT and PT test.

The ABO blood group is known to influence hemostasis because it is a major determinant of the von Willebrand factor (vWF) and FVIII plasma levels.[18] Research shows that non-O blood group individuals are more predisposed to venous thromboembolism (VTE) than individuals of O blood group and have greater levels (approximately 25%) of vWF and FVIII,[19-21] which makes it one of the most significant disease associations described for non-O blood group individuals. Similarly, according to Liu *et al*.[22] and Wang *et al*.,[23] plasma vWF levels and FVIII activity were significantly increased in individuals with non-O type blood compared with those with type O blood in the two groups. Thus, non-O blood groups constitute a risk factor for increased vWF and FVIII in the plasma.

With this established association between blood group and hemostasis, this research was aimed at assessing ABO blood group-dependent variations in PT and APTT which are basic coagulation tests.

Methodology

Study site

This study was conducted at College of Health Sciences, Nnamdi Azikiwe University, Nnewi. The college comprises Faculty of Health Sciences and Technology, which is made up of Medical Laboratory Science, Medical Radiography and Radiological Science, Medical Rehabilitation and Physiotherapy, and Nursing Science; Faculty of Basic Medical Science, which comprises the Department of Human Anatomy and Human Physiology; and Faculty of Medicine. The college has a population of over 2000 students.

Research design

This research is a cross-sectional study designed to assess the levels of APTT and PT in students of different ABO blood groups in the College of Health Sciences, Nnamdi Azikiwe University, Nnewi Campus.

Study population and sampling technique

The sample population was 200 undergraduate students drawn from various faculties and departments in the College of Health Sciences, Nnewi. The individuals were recruited using a convenience sampling technique.

Ethical consideration

The ethical clearance to conduct this research was obtained from the Ethics Committee of Nnamdi Azikiwe University Teaching Hospital (NAUTH), Nnewi, with reference number NAUTH/CS/66/VOL.10/67/2017/038.

Inform consent

Informed consent was obtained from all participants recruited for the study.

Inclusion criteria

All healthy undergraduate students of College of Health Sciences, Nnamdi Azikiwe University, Nnewi Campus, were included.

Exclusion criteria

Those excluded from this research work include:

- Individuals with known bleeding disorders
- Individuals who were sick
- Individuals who have been transfused with blood in the previous 3 months
- Individuals who refused to give their consent.

Sample collection and analysis

Six milliliters of venous blood sample was collected by venepuncture from the individuals aseptically; 4.5 ml was dispensed into a 0.5 ml of 3.2% trisodium citrate sample bottle and the anticoagulated samples were spun at 4000 rpm for 10 min and platelet-deficient plasma was separated for PT and APTT analysis, while the remaining 1.5 ml was dispensed into ethylenediaminetetraacetic acid containers for blood grouping.

ABO blood grouping

The ABO blood grouping was done by the tile method. A drop of anti-A, -B, and -AB was placed on a white-pitted tile, and a drop of blood was placed on each of the antisera and mixed with a glass rod. The white tile was rocked gently for 4 min and was observed for agglutination.

Prothrombin time assay

PT was determined using the manual method as follows. The required volume of PT reagent to be used was removed from the vial and incubated for 10 min at 37°C. Hundred microliters of the test plasma was added into a tube and incubated at 37°C for 3 min. Two hundred microliters of the preincubated PT reagent was rapidly added and the timer was started. The time taken for clot to form was recorded.

Activated partial thromboplastin time assay

APTT was determined using the manual method as follows. The required volume of calcium chloride reagent was removed and incubated for 10 min at 37°C. The required volume of APTT reagent was removed from the vial and brought to room temperature. Hundred microliters of the sample was added to a test tube and incubated at 37°C for 2 min. Hundred microliters of the APTT reagent that is at room temperature was added, and the mixture was incubated for 3 min at 37°C. Hundred microliters of calcium chloride reagent was added rapidly and the timer was started immediately. The time for clot formation was observed and recorded.

Statistical analysis

Statistical Package for the Social Science version 21.0 (IBM, Armonk, NY, United States of America)was used for the data analysis. Results were expressed as mean ± standard deviation, and comparisons between groups and among groups were analyzed using the independent *t*-test and the analysis of variance, respectively. The level of significance was set at $P < 0.05$.

Results

The individuals comprised 90 blood group O individuals (45%), 62 blood group A individuals (31%), 30 blood group B individuals (15%), and 18 blood group AB individuals (9%). Females with O blood group had the highest frequency of 55.5% ($n = 50$), and also generally, there were more female individuals (53.5%, $n = 107$) than males (46.5%, $n = 93$) [Table 1].

Blood group O has a significantly higher APTT when compared with blood groups A, B, and AB. Similarly, blood group A had significantly higher PT when compared with other blood groups (O, B, and AB). Furthermore, PT was significantly higher in blood group AB compared with B ($P < 0.05$) [Table 2].

There was no significant difference in the mean values of APTT and PT when compared between males and females ($P > 0.05$) [Table 3].

Both the mean APTT and PT values were significantly higher in males of blood group AB and B compared to the females ($P < 0.05$) [Table 4].

Table 1: Frequency of ABO blood group among the test individual based on gender

Blood group	Gender		Total, frequency (%)
	Male, *n* (%)	Female, *n* (%)	
O	41 (45.6)	49 (54.4)	90 (45.0)
A	29 (46.8)	33 (53.2)	62 (31.0)
AB	12 (66.7)	6 (33.3)	18 (9.0)
B	12 (40.0)	18 (60.0)	30 (15.0)
Total	94 (47.0)	106 (53.0)	200 (100)

Table 2: Comparison of activated partial thromboplastin time and prothrombin time among the different ABO blood groups

Blood groups	APTT	PT
O	44.24±15.10	14.32±2.37
A	39.35±12.12	16.70±2.53
AB	37.22±8.15	15.38±1.79
B	35.93±9.78	13.53±2.16
F (*P*)	4.210 (0.007*)	17.478 (0.000*)
O versus A: *P*	0.024*	0.000*
O versus AB: *P*	0.038*	0.080
O versus B: *P*	0.003*	0.113
A versus AB: *P*	0.541	0.037*
A versus B: *P*	0.238	0.000*
AB versus B: *P*	0.740	0.009*

*P value significant at <0.05. APTT=Activated partial thromboplastin time, PT=Prothrombin time

Table 3: Comparison of activated partial thromboplastin time and prothrombin time between male and female

Gender	APTT (s)	PT (s)
Female (*n*=106)	39.27±13.30	14.69±2.33
Male (*n*=94)	42.63±13.18	15.43±2.88
t	−1.787	−1.970
P	0.075	0.050

APTT=Activated partial thromboplastin time, PT=Prothrombin time

Table 4: Comparison of activated partial thromboplastin time and prothrombin time among the different blood group based on gender

Parameter	Blood group	Female (*n*=106)	Male (*n*=94)	*t*	*P*
APTT	O (*n*=90)	42.20±13.63	46.80±16.58	−1.445	0.152
	A (*n*=62)	40.27±13.34	38.31±10.71	0.633	0.529
	AB (*n*=18)	29.50±8.71	41.08±4.42	−3.801	0.002*
	B (*n*=30)	32.27±9.41	41.41±7.79	−2.783	0.010*
PT	O (*n*=90)	14.46±2.12	14.15±2.68	0.613	0.541
	A (*n*=62)	16.27±1.82	17.20±3.11	−1.464	0.149
	AB (*n*=18)	14.17±1.17	16.0±1.76	−2.295	0.036*
	B (*n*=30)	12.56±2.06	15.00±1.34	−3.610	0.001*

**P* value significant at <0.05. APTT=Activated partial thromboplastin time, PT=Prothrombin time

Disscusion

PT and APTT are hemostatic indices that give an insight into the coagulation status of individuals,[16] and these tests are usually utilized to screen for coagulation factor deficiencies.[14,15] There are a limited number of studies on the effect of gender and ABO blood group on the levels of APTT and PT.

This study showed a significant variation in APTT and PT among individuals of different blood groups evaluated. Blood group O showed a significantly higher APTT when compared with non-O blood groups while blood group A showed a significantly higher PT when compared with other blood groups. This agreed with the works done by Choi *et al*.[24] and Fourel *et al*.[25] that APTT was significantly prolonged in those with type O blood group compared with those with type non-O. However, this disagreed with another findings of Choi *et al*.[24] that PT was not significantly different between those with type O blood group and non-O blood group types.

A higher APTT or PT may suggest that the concerned individuals may be more likely to be predisposed to bleeding conditions. According to Robert *et al*.,[26] group O individuals have the tendency to bleed and non-O blood groups to thrombose; thus, individuals with O blood group have less risk of VTE when compared with the individuals of other blood groups (A, B, and AB). A lower APTT level on non-O blood group individuals may also be linked to the association of non-O blood group having an increased risk of coronary heart disease[7] and VTE.[27]

The connection of this finding to the established report that blood group O individuals have a lower plasma concentration of vWF than individuals with other blood group types[18] is not clearly defined. The presence of ABH antigenic structures on circulating vWF has been identified as the molecular basis of this phenomenon, which modulate the activity of this protein through different degrees of glycosylation.[28]

Fourel *et al*.[25] reported that sex has a significant influence on APTT, with lower mean values in females (30.9 s) than in males (31.6 s), while Abdullah *et al*.[29] and Aral *et al*.[30] suggested that PT levels differ between ages and gender. Our study found no significant variations in APTT and PT when both genders were compared while blood groups AB and B males have a higher APTT and PT level compared to females.

The distribution pattern of the ABO blood antigen varies among different populations in the world. As expected, blood type O was the prevalent ABO blood group in the present study which agrees with the established findings of previous studies.[31]

Conclusion

APTT and PT levels differ among individuals of different ABO blood groups, with blood group O and blood group A individuals having a significantly higher APTT and PT, respectively. This may suggest that blood group of individuals may affect their intrinsic and extrinsic coagulation mechanisms.

Recommendation

It is recommended that further research should be carried out with larger population and wider geographic coverage to take cognizance of racial, ethnic, and possible geographical variations that may enhance the findings.

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Conflicts of interest

There are no conflicts of interest.

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