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ASSESSMENT SERUM GLUCOSE AND PLASMA GLUCOSE UNDER IDENTICAL CONDITIONS

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AUTHOR'S CONTRIBUTION

The sole author designs the study, performed statistical analyses and wrote the final manuscript.

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Short Research Article

ABSTRACT

According to the International Diabetes Federation, South and Central America region has the proportion of 41.9% people with diabetes who are undiagnosed. Several factors influence the stability of glucose values after collection as "*in vitro*" glycolysis. Aim of this study was to compare the fasting glucose levels either in plasma or in serum under identical conditions.

Methodology: Blood samples were collected in K2 EDTA and serum tubes with clot activator and both tubes were maintained in upright position for 30 min at room temperature to allow clot formation. Also, linear regression model was used for evaluate la relationship between glucose plasma and glucose serum and multiple linear regression was used and two model for obtain coefficients adjusted by hematology parameters covariates.

Results: Mean glucose in serum tube was -1.57 mg/dl than K2 EDTA tube and that was no statistically significant difference for glucose ($p = 0.41$) and neither clinically significant. But on the other hand, serum glucose increases by 1 mg/dl; while EDTA glucose increases by an average of 0.59 mg/dl ($p<0.05$).

Conclusion: Serum glucose is similar to plasma glucose when hematology parameters between the reference range.

Keywords: Serum glucose; plasma glucose; preanalytical; glycolysis.

1. INTRODUCTION

"In recent years, Diabetes has become a public health epidemic, this disease is characterized when the pancreas does not produce enough insulin or when the body cannot effectively use the insulin it produces. According to the International Diabetes Federation (IDF), the global prevalence of diabetes was estimated by 9.3%. Nevertheless, South and Central America region has the proportion of 41.9% people with diabetes who are undiagnosed" [1].

"The measure of blood glucose assay is one of the most frequent laboratory assays, employed for diabetes diagnosis and treatment. American diabetes Association (ADA) and World Health Organization (WHO) recommend plasma glucose as specimen of choice since the concentration of glucose in plasma is higher than in whole blood due its higher water content. Several factors influence the stability of glucose values after collection, being *in vitro* glycolysis the main cause of reduction at a rate of 5% to 7% per hour" [2,3]. "Accelerated decrease can be observed with increased ambient temperature and in samples with high white blood cell, platelet and erythrocyte counts" [3,4]. Therefore, the aim of this study was to compare the fasting glucose levels either in plasma or in serum under identical conditions.

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2. MATERIALS AND METHODS

2.1 Study Design

A cross sectional and descriptive study.

2.2 Samples

Blood sample was residual sample collected previously, 21 laboratories personal, apparently healthy without chronic diseases and medications, by a single phlebotomist. Blood samples were collected in K2 EDTA (dipotassium EDTA) and serum tubes with clot activator. Both tubes were maintained in upright position for 30 min at room temperature to allow clot formation. Serum and K2 EDTA tubes were then centrifuged at 3500 rpm for 10 min at room temperature. All serum and plasma aliquots frozen at – 60 °C until measurement. Also, all sample were thawed at the same time at room temperature.

The sample size was performed using software for epidemiological statistics, OpenEpi version 3.01, based on the study Kang et al. [5]. Mean glucose plasma was 119.4 ± 9.9 mg/dl and serum glucose were 108.5 ± 6.5 mg/dl, a confidence level 95% and power of 90%. Therefore, minimum sample size was 12 subjects.

Glucose samples were measured in a single run-in duplicate by glucose oxidase method on the semi autoanalyzer CONTEC BC 300 and blood cell count was processed immediately after collection with a CELL – DYN Emerald 22 (Abbot, USA). Both instruments were previously being calibrated against appropriate standard material and verified with the use of proprietary controls.

2.3 Statistical Analysis

Categorical variables were expressed as absolute and relative frequency, but on the other hand, continuous variables were described by mean ± SD because all data were checked previously for normal distribution by the Shapiro - Wilk test; also, this test is crucial the assumption for paired T - test where differences of pairs are normally distributed. Bivariate analysis between EDTA and serum glucose was assessed by paired T – test, where null hypothesis is mean of paired difference is zero.

Linear regression model was used for evaluate la relationship between glucose plasma and glucose serum with different assumption that there previously evaluate. Multiple linear regression was used and two model for obtain coefficients adjusted by covariates. Coefficients were not adjusted for any variable in the crude model, model 1 was adjusted for White Blood Cell (WBC), Red Blood Cell (RBC) y Platelet (PLT) and model 2 adjusted was RBC and PLT.

"The bias for each tube were calculated according to the formula: mean difference (%) = [(test tube mean-reference tube mean/reference tube mean) x 100] also Bland-Altman plot was used to assess the agreement between the sample types. A p value <0.05 were considered statistically significant" [6].

Finally, bias from serum glucose and plasma glucose were compared with the current desirable allowable bias based on biological variation. Analysis was performed using MedCalc Statistical software, version 13 (MedCalc, Mariakerke, Belgium).

3. RESULTS

A total of 21 subjects were enrolled in the study, male was 14 (66.67%) also mean age 30.14 ± 9.16 and laboratory parameters of the study population are summarized in Table 1.

Table 1. Clinical chemistry and hematology parameters

Test	Mean ± SD
EDTA glucose (mg/dl)	91.45 ± 10.38
Serum glucose (mg/dl)	89.88 ± 13.20
White blood cell (10^9/L)	7.5 ± 1.41
Red blood cell (10^{12}/L)	4.57 ± 0.41
Platelet (10^3/L)	321.76 ± 72.82
Hemoglobin (g/dl)	14.20 ± 1.35
Mean cell volumen (fl)	90.04 ± 4.22
Mean hemoglobin concentration (g/dl)	31.05 ± 1.56
RDW (%)	12.66 ± 0.68
Mean Platelet volumen (fl)	7.84 ± 0.68

Average glucose in serum tube was -1.57 mg/dl than K2 EDTA tube and that was no statistically significant difference for glucose (P = 0.41); therefore, both specimens are similar. But on the other hand, it does not exceed the desirable bias based on biological variation thus not clinically significant (Fig. 1).

Comparison data are shown Table 2. But on the other hand, Lin's concordance (CCC = 0.73) showed substantial agreement between methods, with a very strong linear association (r = 0.76), and good accuracy (Cb = 0.96). In addition, when serum glucose increases by 1 mg/dl; while EDTA

Table 2. Comparison studies between EDTA and serum glucose

Sample	Mean ± SD	Bias (P value)	Bias (%) (P value)	Linear regresión	Desirable bias (%)
EDTA	91.45 ± 10.38				
Serum	89.88 ± 13.20	-1.57 (0.41)	-1.74 (0.42)	Model crude: EDTA = 37.69 + 0.59 serum	2.34
				Model 1: EDTA = 18.88 + 0.62 serum – 0.17 WBC – 0.03 PLT +5.97 Model 2: EDTA = 18.85 +0.62 serum -0.03PLT +5.88 RBC	

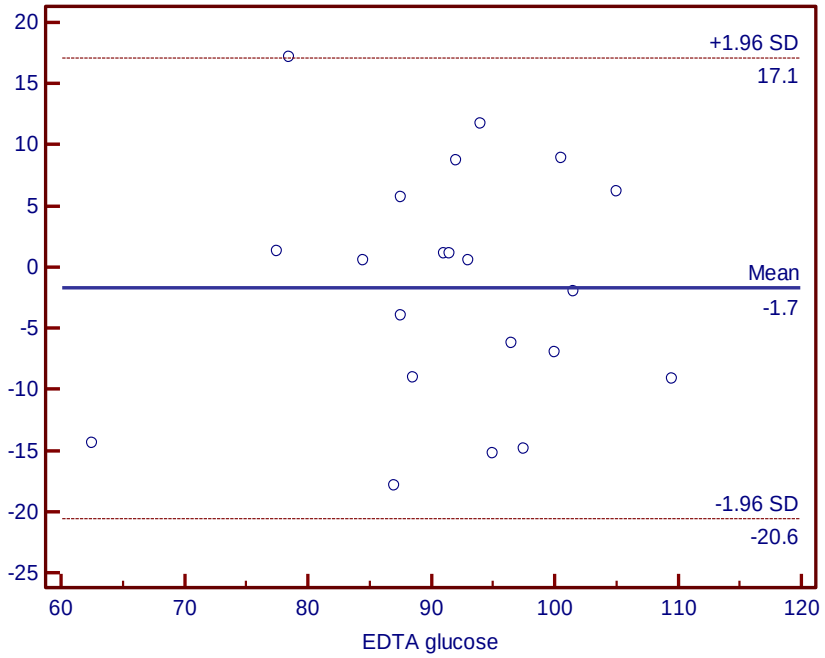

Fig. 1. Bland Altman plot

glucose increases by an average of 0.59 mg/dl (P<0.05) and when adjusted for PLT and RBC it increases by 0.62 (0.03 mmol/l) statistically significant (P < 0.05) and where this last model explains the variation of EDTA glucose by 60.2%.

4. DISCUSSION

Diabetes has increased in recent years in our country and the prevalence in Peru according to the IDF is 6.6% of the adult population between 20 and 79 years of age, however, 40% of people with diabetes are not previously diagnosed [7]; this may be due to different causes such as: the patient's conditions, the standardization in the processing of the fasting glucose test and the collection of the sample in an adequate way and handling prior to the analysis, this last point being important because glycolysis in vitro can be an important factor in the final result.

There is still a discrepancy as use or not to use serum glucose measurement because some studies mention that it is slightly higher or lower than plasma [2] and this is due to the fact that glucose in plasma has a lower concentration of water, in addition, due to the contact that it has with it cells with the serum while the retraction of the clot is formed or glucose in the plasma is 5% lower than in the serum, due to the possible leakage of liquid from the red blood cells due to the action of anticoagulants [3-4]. Gambino et al. and Lippi et al. showed heparin glucose plasma was 0.9% and 1.3% higher than serum, respectively, under the same conditions [8,9].

Our study reported – 1.57mg/dl (0.09 mmol/l) difference between serum glucose and plasma glucose in the same resting time and no clinical relevance was found. On the other hand, the study differs from that reported by Frank et al. where glucose in EDTA was lower compared to serum. Meanwhile, we report that EDTA glucose was 1.74% higher than serum; Dimesky et al. found a 5.5% greater difference in EDTA glucose versus serum glucose; Similarly, Kang et al. found a 9.12% greater difference in plasma glucose than serum glucose [5,10,11]. This difference is explained by the fact that in both studies the plasma samples were centrifuged immediately and processed, while the serum samples waited for clot formation.

Finally, when serum glucose is adjusted to PLT and RBC, it only explains 60.2% of the variation in EDTA glucose; therefore, we suggest that the percentage difference is due to the components that differ between the serum and plasma matrix. A limitation study is that a smaller sample size can influence no significant difference; however, according to our sample size minimum size was 12 subjects, and the findings of this research may differ from other clinical chemistry analyzers and kits.

5. CONCLUSION

Serum glucose is similar to plasma glucose when hematology parameters between the reference range because no statistically significant difference and not exceeded desirable bias on biological variation. Future research should evaluate glucose serum and plasma in diabetics patients adjusted for a cell blood count.

CONSENT

It is not applicable.

ETHICAL APPROVAL

The study, which was performed in accord with the ethical standards established by the institution in which the experiments were performed and the Helsinki Declaration of 1975.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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