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Determination of the compatibility between arterial samples and blood samples from arteriovenous fistulas for ESRD patients

Osama Younis Hamid
Biochemistry Department, College of Science, Tikrit University, Tikrit, Iraq
Email: osama.y.hamid.chem764@st.tu.edu.iq

Prof.Dr. Nazar Ahmed Naji Abed
Biochemistry Department, College of Science, Tikrit University, Tikrit, Iraq

***Abstract*---**Arterial blood gases (ABG) is a common and gold standard procedure and is often used to assess acid-base status and electrolytes. Arterial blood sampling is technically difficult and painful and causes rare but serious complications for the patient (such as vascular injury or embolism). The blood gas analysis of samples drawn from the arteriovenous fistula (AVF) requires fewer punctures and is a relatively safer and less painful procedure for the patient. The study included (22) patients and a blood gas analyzer (ABL800 FLEX PLUS blood gas analyzer) was used. The results showed that there were no clinically significant differences between the arterial blood sample and the arteriovenous fistula sample.

***Keywords*---**arterial blood gases (ABG), arteriovenous fistula (AVF), ESRD.

1. Introduction

The kidneys are one of the important organs in the human body due to their great importance in helping the body get rid of waste. The structural and functional unit of the kidneys is the nephron, which affects the changes that occur in the blood plasma through filtration, reabsorption, excretion and excretion. Through these mechanisms, the kidneys maintain Electrolyte concentration, fluid volume, osmolality, and acid-base balance [2][1] Electrolyte imbalance and acid-base imbalance are major causes associated with bone demineralization, muscle catabolism, and increased risk of chronic kidney disease development and mortality [3]. Patients with end-stage renal disease require dialysis. To facilitate dialysis, an arteriovenous fistula is performed in the upper extremity and often on the left side. High pressure in the artery leads to regurgitation of the venous system. The vein expands and elongates in response to increased blood flow and

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shear stress. There is a mixture of arterial blood with venous blood. Diversion of venous blood to arterioles leads to higher oxygen saturation, higher oxygen tension, and the greater the flow through the fistula, the greater the chance of measuring oxygen saturation [4], Patients with end stage renal failure usually need continuous monitoring by conducting tests to follow up on the patient's condition. The ABG test includes puncturing the artery with a fine needle and withdrawing a small amount of blood [5] The test is used to determine the pH of the blood, the partial pressure of carbon dioxide and oxygen, the level of bicarbonate and electrolytes, and Concentrations of lactate, hemoglobin and some other variables [6] for acutely ill patients, including patients with renal failure. Repeated direct blood sampling from the artery (the most common puncture site is the radial artery in the wrist). It causes pain and rare but serious complications for the patient such as vascular injury or blockage and infections [7] As for the analysis of blood gases from arteriovenous fistulas, it requires fewer punctures and is a relatively safer procedure for both the patient and the health care provider [2] and may be an alternative to this ABG analysis The study will help us to explain the value and share it with each other and the rapid and reliable management of patients with renal failure [8].

2. Methods

Samples were withdrawn for patients suffering from chronic renal failure and undergoing regular dialysis (two or three times a week) at Ibn Sina Teaching Hospital in Mosul (Industrial Kidney Division) before performing the dialysis process. The study included (22) samples (20) samples. Males and (2) female samples aged between (25-60) years, after obtaining the consent of the patient and his companion to withdraw a sample from the artery (radial artery in the wrist) and arteriovenous fistula at the same time and perform tests that included blood gases, electrolytes and (pH) And ($cHCO^-_3$) immediately after the sample was drawn, and the ABL800 FLEX PLUS Blood gas analyzer was used, which is designed for use on whole blood samples. The ABL800 device relies on three principles. Potentiometric measuring principle, Amperometric measuring principle, and Optical measuring principles.
The materials prepared by the company (Radiometer Medical ApSAkandevej 21 2700 Brenshøj Denmark) were used. The ABL800 device works with high efficiency and reliability and requires a small blood sample (35 µL) and gives the result directly within (30 seconds) [9].

3. Statistical analysis

The data were collected and entered into Microsoft Excel 2010) and the analysis was performed using the (IBM: SPSS Statistics 25) program, where the arithmetic mean and standard deviation of the variables included in the study were found using Independent-samples T-Test and the comparison between the means was done through a test Statistical hypotheses at the level of significance (P-value < 0.05, α = 5%). The correlation coefficient was measured by Pearson's moment correlation coefficient, and Bland-Altman plots were used to determine the concordance between ABG and AVF measurements.

4. Results and Discussion

The statistical results of the current study, as shown in Table (1) and Figure (1), indicated that there was no significant difference between the arterial blood sample and the blood sample from the arteriovenous fistula. Acidity, bicarbonate, lactate, molecular pressure of carbon dioxide, total concentration of hemoglobin, percentage of saturation of oxygen (sO2) and molecular pressure of oxygen (pO_2). The results agree with researcher (Menezes) and his colleagues [10] and Pearson's coefficient (r) was found. The results of the variables taken from the arterial sample and samples Arteriovenous fistulas are highly correlated and there were very strong and strong positive correlations between the values of (K^+), (Na^+), (CL^{-1}), (Ca^{+2}), (pCO_2), (sO_2), ($cHCO^-_3$), (PH), (ctHb) and (Lac), and an average positive correlation in the value of (pO_2), which is shown in Table (1).

Table (1) p-value and correlation coefficient of arterial blood samples and blood samples from arteriovenous fistula

Parameters	ABG Mean±Std.Deviation	AVF Mean±Std.Deviation	p-value	Correlation Coefficient (r value)
Number	22	22	--------	**--------**
K^+(mmol/L)	4.8368±1.02427	4.8474±1.03353	.975 NS 0	0.988
Na^+(mmol/L)	139.2105±2.63690	138.5789±2.81496	.480 NS 0	0.918
Ionized Ca+2 (mmol/L)	1.0301±0.15305	1.0116±0.16597	.723 NS 0	0.980
CL^{-1}(mmol/L)	108.0000±3.92994	106.5789±3.51688	.248 NS 0	0.816
PH	7.3461±0.05087	7.3433±0.06009	.878 NS 0	0.887
$cHCO^-_3$(mmol/L)	16.5263±2.42644	16.5158±2.31283	.989 NS 0	0.892
pCO_2(mmHg)	34.7895±3.84518	33.5368±3.96291	.329 NS 0	0.976
sO_2(%)	96.8211±1.51862	±2.04816 96.0132	0.176 NS	0.191
pO_2(mmHg)	96.0211±13.77923	101.4947±17.28115	.288 NS 0	0.501
Lac(mmol/L)	1.3368±0.45730	1.3579±0.54090	.898 NS 0	0.968
ctHb (g/dL)	9.3211±1.51569	9.5000±1.42906	.710 NS 0	0.992

ABG, arterial blood gas, AVF, Arteriovenous fistula, NS=Non Significant p>0.05

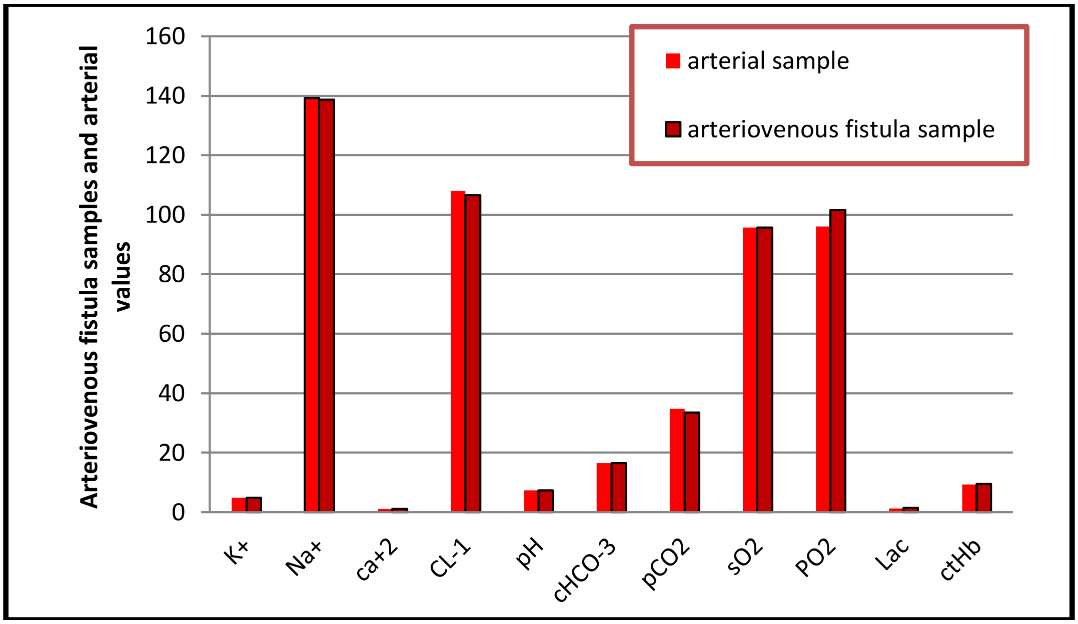


Figure 1. Comparison of mean arterial blood samples with blood sample from arteriovenous fistulas.

High correlation does not mean that the two methods agree because (r) measures the linear correlation and the strength of the relationship between two variables, not the agreement between them. The change in the measurement does not affect the correlation, but it definitely affects the agreement. For this reason, Bland-Altman plots were used to find out the amount of acceptable difference in the measurement without causing With the emergence of clinical problems, the Bland-Altman plot is a graph for accurately analyzing the concordance between two basic variables by finding the difference between the means and the standard deviation of differences using the One-Sample T-Test. Altman) The y-axis represents (Y) the difference between the measurements for each item (Difference) and the x-axis (X) represents the average of the measurements (Average) We determine the confidence level (95%) and look for the value (Z) corresponding to it and equal to (1.96) and we calculate the confidence interval (Limits of agreement (LOA) through the following equations [11].

Upper Limit (UL) = Mean of difference + (1.96 x Standard deviation of difference)
Lower Limit (LL) =Mean of difference - (1.96 x Standard deviation of difference)
The results of the limits of agreement (LOA) shown in Table (2) and (Bland-Altman) charts (Figures (2) (3) (4) (4) (5) (6)) showed that the limits of agreement (95%) are within the acceptable limits, i.e. 95% of the differences fall within the acceptable limits. Within the range extending between (Upper Limit, Lower Limit) and close to the average line, which is called the limits of agreement between the measurements when confidence occurs (95%) and is considered clinically unimportant and interchangeable. blood from the arteries.[12] Which reduces the risk of arterial hematoma, dissection and thrombosis, in addition to giving results in a short time compared to the results of venous blood in other devices that take longer.

Table (2) Difference between means and limits of agreement (LOA) for arterial blood samples and blood samples from arteriovenous fistulas

Parameters	ABG Mean±Std.Deviation	AVF Mean±Std.Deviation	(A-AVF) difference Mean±Std.Deviation	Bland-Altman 95% (LOA)
Number	22	22	--------	**--------**
K^+(mmol/L)	4.8368±1.02427	4.8474±1.03353	-0.1053±0.1594	-0.4177 to 0.2071
Na^+(mmol/L)	139.2105±2.63690	138.5789±2.81496	0.6315±1.1160	-1.5558 to 2.8188
Ionized Ca+2 (mmol/L)	1.0301±0.15305	1.0116±0.16597	0.0184±0.0342	-0.0484 to 0.0854
CL^{-1}(mmol/L)	108.0000±3.92994	106.5789±3.51688	1.4210±2.2928	-3.0728 to 5.9148
PH	7.3461±0.05087	7.3433±0.06009	0.0028±0.0278	-0.0516 to 0.0572
$cHCO^-_3$(mmol/L)	16.5263±2.42644	16.5158±2.31283	0.0105±1.1064	-2.1580 to 2.1790
pCO_2(mmHg)	34.7895±3.84518	33.5368±3.96291	1.2526±0.8713	-0.4551 to 2.9603
sO_2(%)	96.8211±1.51862	±2.04816 96.0132	1.1105±2.0986	-3.0027 to 5.2237
pO_2(mmHg)	96.0211±13.77923	101.4947±17.28115	-5.4737±15.8078	-36.456 to 25.509
Lac(mmol/L)	1.3368±0.45730	1.3579±0.54090	-0.0211±0.1512	-0.3174 to 0.2752
ctHb (g/dL)	9.3211±1.51569	9.5000±1.42906	-0.1789±0.2097	-0.5899 to 0.2321

ABG, arterial blood gas, AVF, Arteriovenous fistula, *(A-AVF)* arterial minus Arteriovenous fistula difference*, (LOA)* limits of agreement

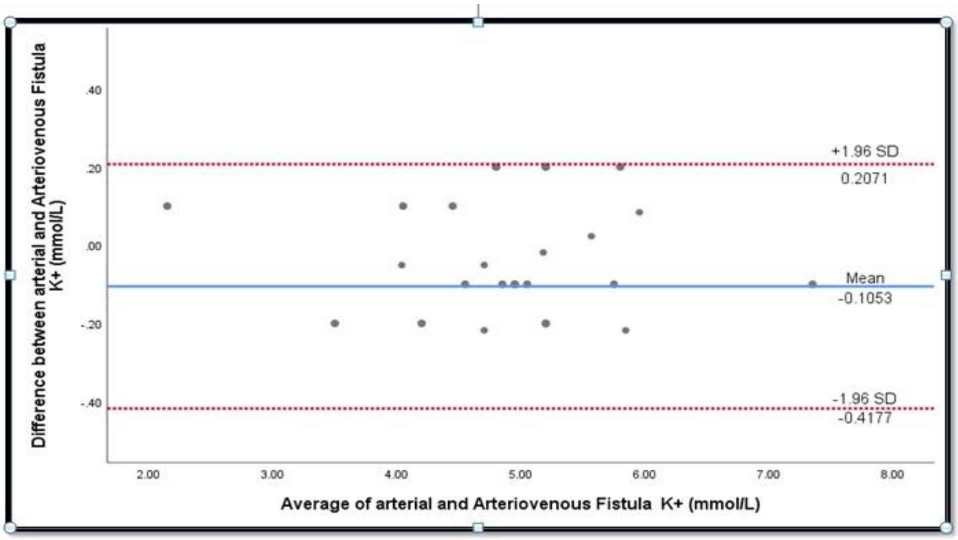
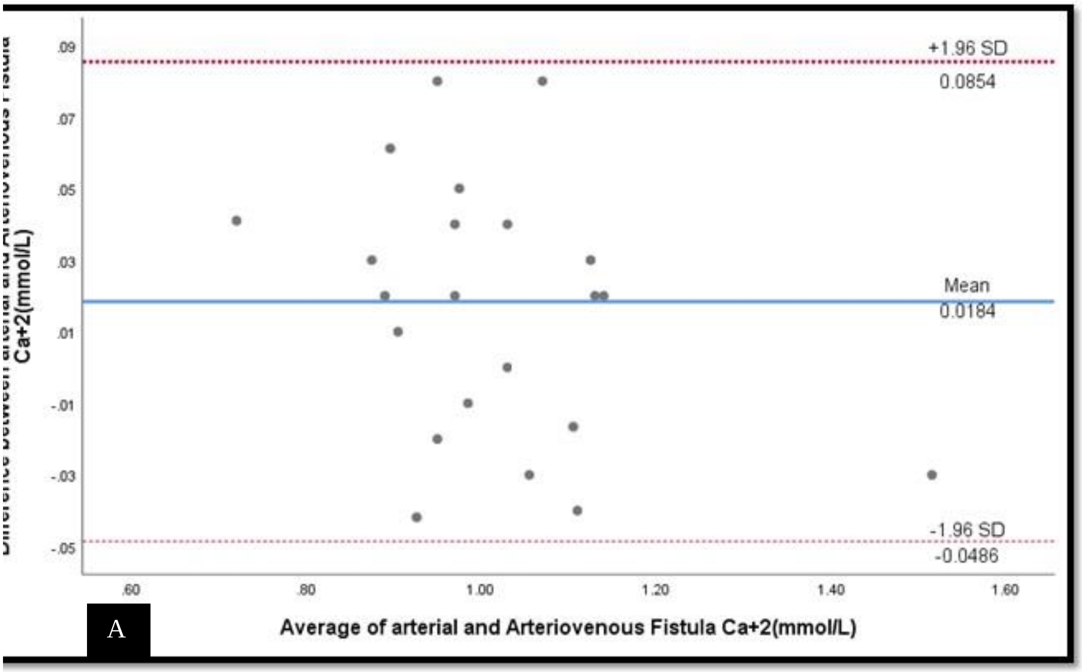


Figure 2. Bland-Altman chart of the arteries and arteriovenous fistula (mean vs. difference) for (K^+)



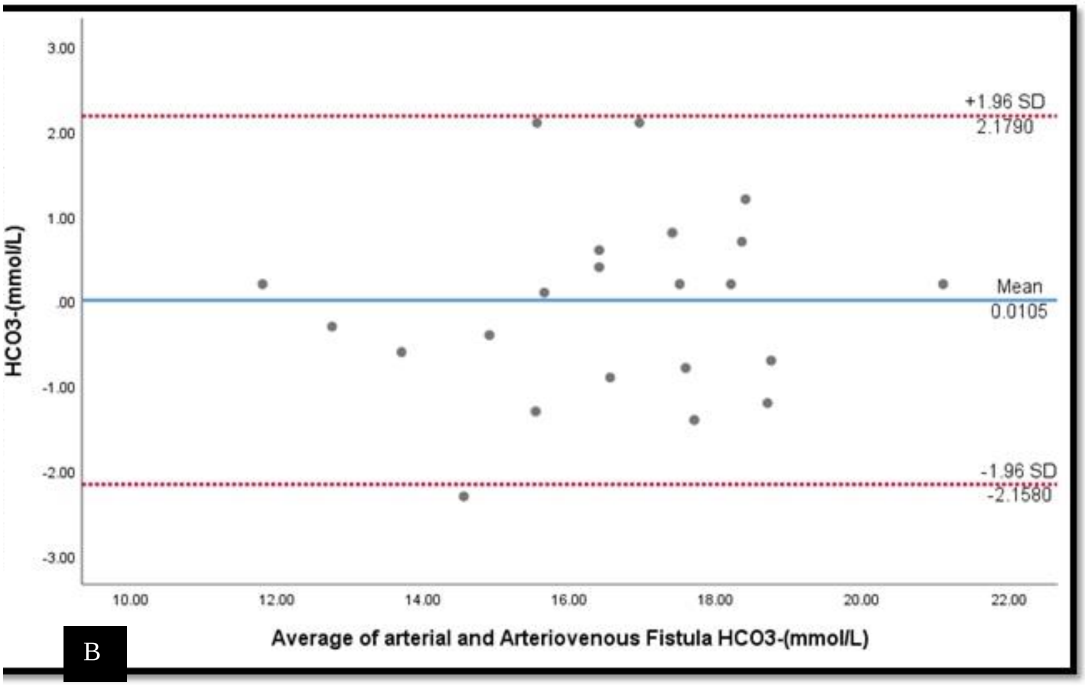
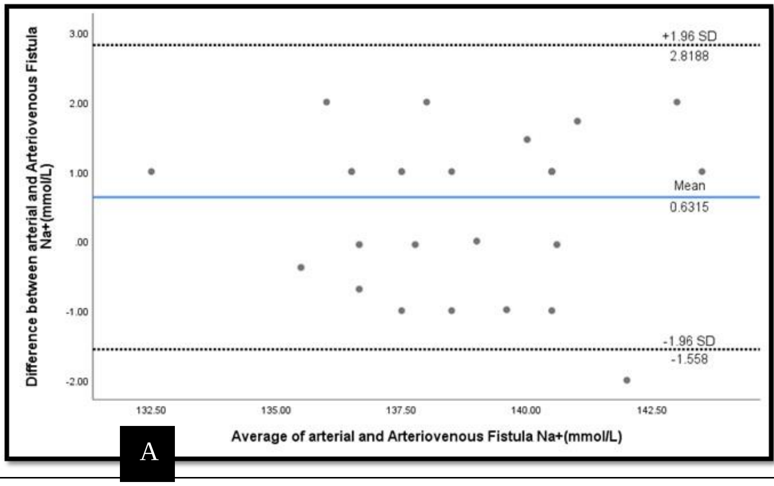
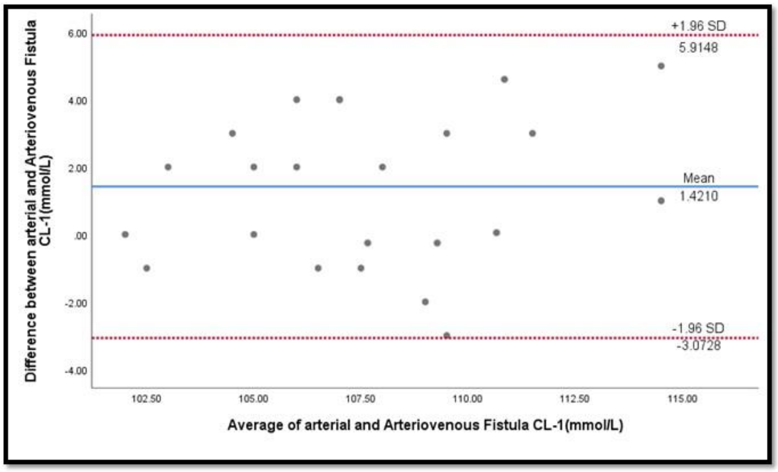


Figure 3. Bland-Altman chart of the arteries and arteriovenous fistula (mean vs. difference) (A) Ca+2, (B) HCO3-





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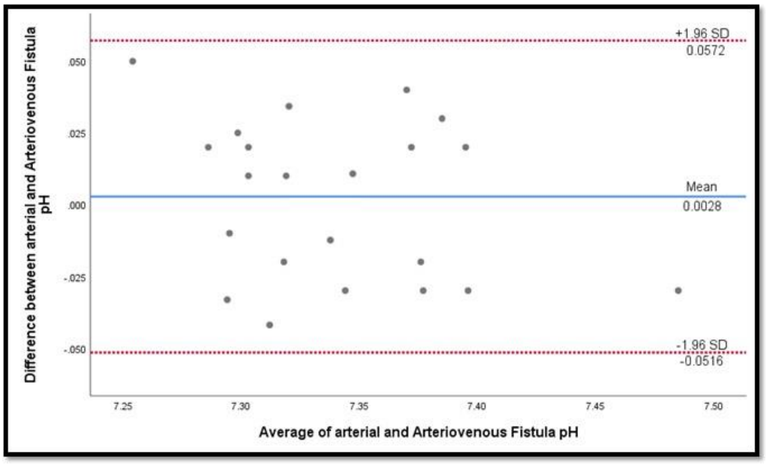
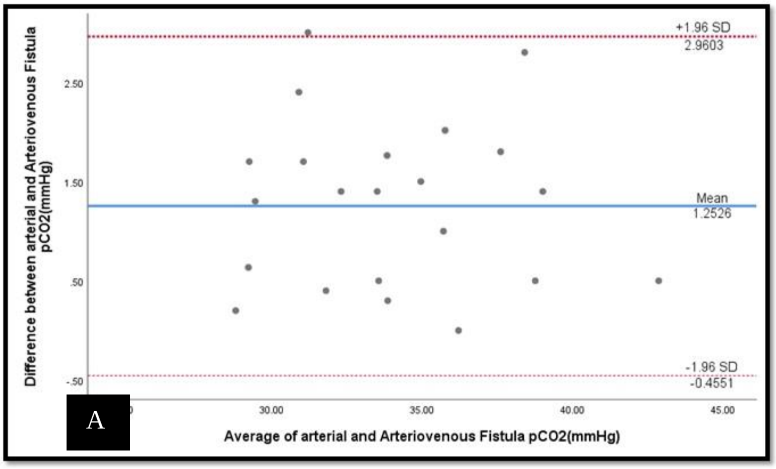


C

Figure (4) Bland-Altman chart of the arteries and arteriovenous fistula (mean vs. difference) (A) Na+, (B) CL-1, (C) pH



A

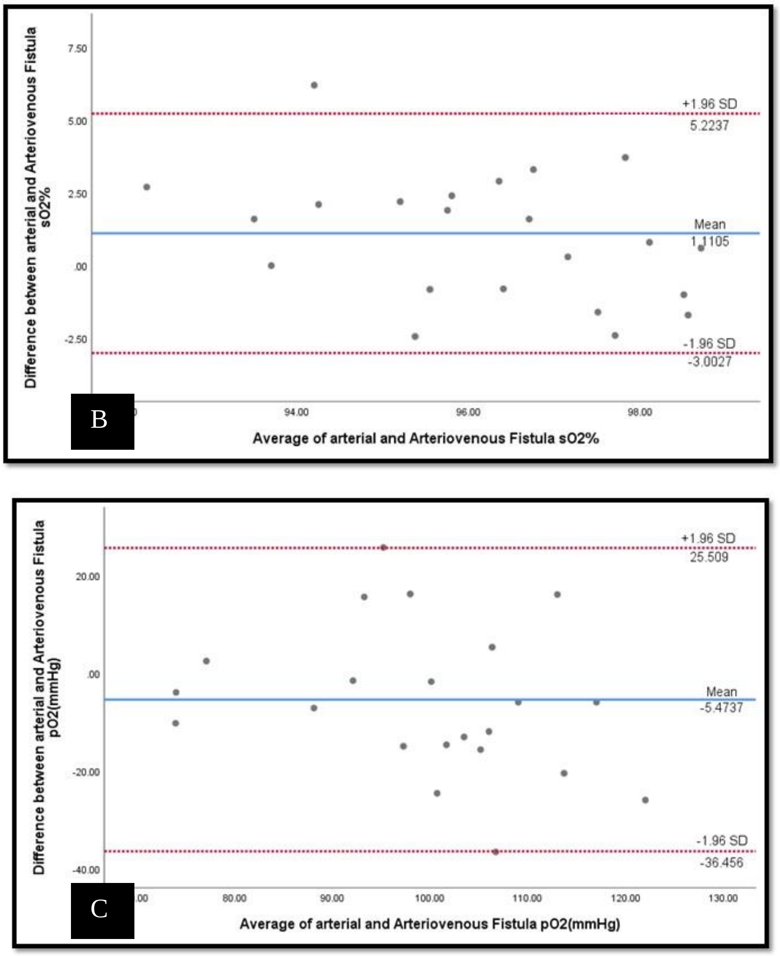
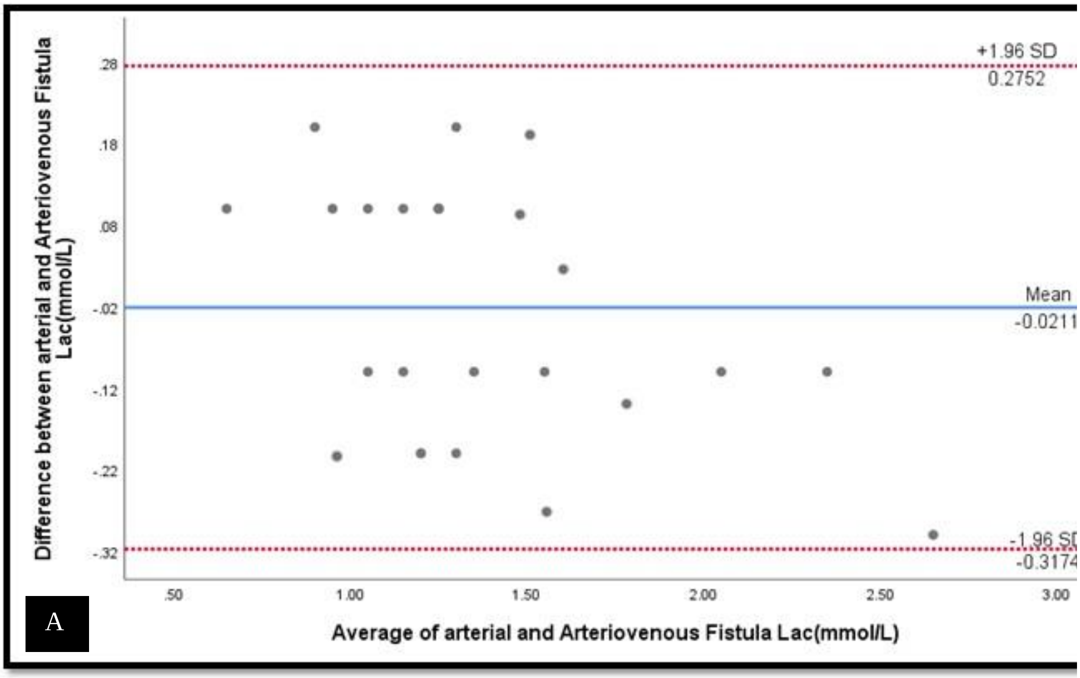


Figure (5) Bland-Altman diagram of arteries and arteriovenous fistulas (mean vs. difference) (A) pCO2, (B) sO2, (C) pO2



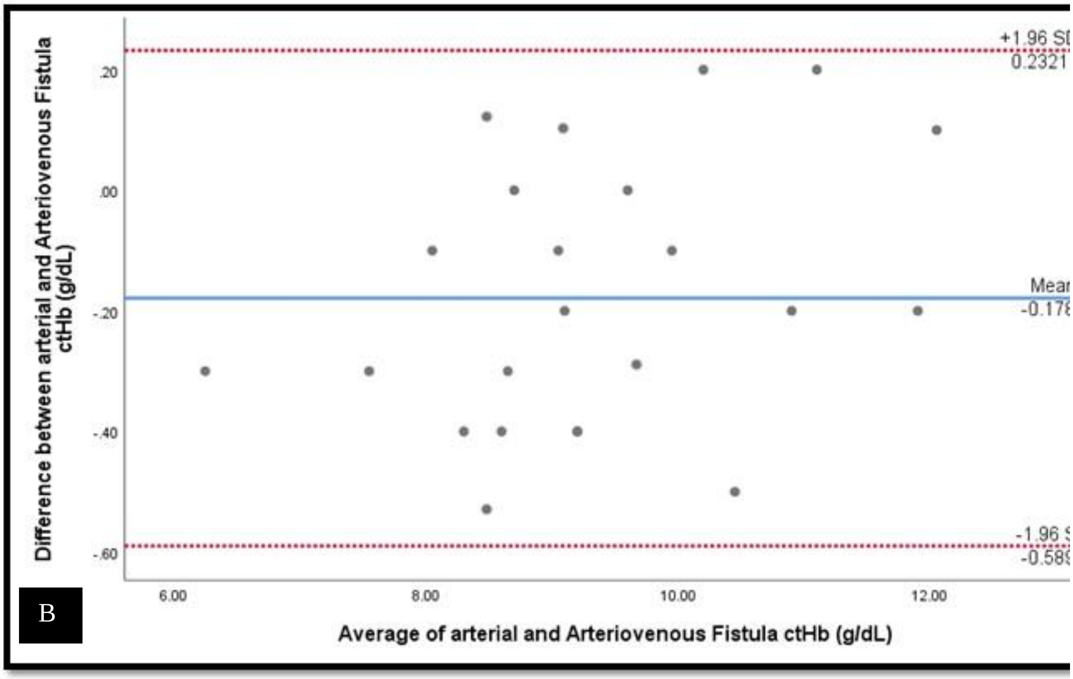


Figure (6) Bland-Altman chart of the arteries and arteriovenous fistula (mean vs. difference) (A) Lac, (B) ctHb

5. Conclusions

AVF can be used safely instead of ABG, which has many risks during treatment and follow-up of patients with ESRD in parameters of potassium, sodium, ionic calcium, pH, bicarbonate, lactate, carbon dioxide molecular pressure, total hemoglobin concentration and oxygen saturation (sO_2) and molecular pressure of oxygen (pO_2) and in this way it is possible to avoid the occurrence of frequent, difficult and painful arterial perforations and the possibility of obtaining results in record time.

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