Research Article

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Comparison of Barricor tube and serum separator tube in outpatients

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Abstract

Objectives: In clinical laboratories, it is common to obtain serum and plasma by using a barrier tube due to its various advantages. In this study, we aimed to compare 18 biochemistry analytes in outpatient clinic and outpatient oncology patients by measuring in a Barricor tube and a serum separator tube (SST).

Methods: Venous blood was drawn into the Barricor tube and SST from volunteers consisting of outpatients and outpatient oncology patients. The biochemical parameters were measured using the AU2700 autoanalyser (Beckman Coulter Inc., CA, USA) and Beckman Coulter Access immunoanalyser (Beckman Coulter Inc., CA, USA). The biochemical analytes evaluated in the two participant groups were compared between the Barricor tube and SST.

Results: In the study, when the results in both the outpatient group and the outpatient oncology patient group, bias (%), allowable bias (%), CV (%), allowable CV (%), total error (%), total allowable error (TEa) (%) were evaluated; potassium (K) total error (%) between Barricor tube and SST exceeded TEa, however, all other parameters were within TEa.

Conclusions: Considering its various advantages and compared biochemical analytes, we think that can be switched to the Barricor tube in clinical laboratories and the reference range change can be made for K.

Keywords: Barricor tube; plasma; serum; serum separator tube.

Introduction

The pre-analytical phase involving the stages before the laboratory analysis significantly affects analytes measured in laboratories [1]. The blood collection tube is one of the factors affecting the pre-analytical phase which includes test request, patient identification, blood sampling, sample handling, sample preparation, sorting out, and sample storage stages. Tube components such as anticoagulants, blood tube stoppers, stopper lubricants, tube walls, surfactants, clot activators, separator gels, or mechanical separators can interact with blood components [2]. Therefore, the quality of the tube used in laboratories can affect the patient outcome [3, 4].

The common type of sample used in biochemistry laboratories is serum or lithium heparin plasma [4]. The difference between plasma and serum is that the plasma is obtained by centrifugation of the blood taken into the anti-coagulated tube. Therefore, the plasma comprises fibrinogen and coagulation proteins, and the serum is obtained by centrifugation after coagulation is completed. Thus, the serum doesn't contain fibrinogen and coagulation proteins. The plasma has some advantages in that there is no waiting time after blood collection and before centrifugation, the amount obtained after centrifugation is high, and turnaround time (TAT) is reduced [5]. Additionally, the World Health Organization (WHO) reported that plasma represents the pathological status of the patient better than serum [6].

Some advantages of the gel separator tube include ease of use, the ability to work from the primary tube, and rapid separation of blood from its cellular components. On the

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other hand, it has also some disadvantages such as the effect of the gel used as a separator on some analyte concentrations, probe occlusion of the analyzer, and contamination in the cuvette [2, 7–9]. For this reason, tube manufacturers have developed various tubes with new features.

One of the novel tubes is the Barricor tube developed by Becton, Dickinson and Company (BD; Franklin Lakes, NJ, USA). The Barricor tube comprises a mechanical separator instead of a gel separator and lithium heparin as an anticoagulant. Due to the use of the anticoagulant lithium heparin, the sample can be obtained directly after centrifugation without a clotting step.

TAT is delineated as the duration time between test request and result reporting. TAT is a substantial clinical performance indicator in the laboratory process. It was mentioned that the reducing TAT was the second important performance indicator for clinicians after the quality and reliability of laboratory test results [10].

Barricor tube can be effective in reducing TAT in laboratories. Plasma samples can be centrifuged directly after blood collection, dissimilar to serum, in which clotting is completed after 30 min. Thus, the Barricor tube is centrifuged without waiting, from which at least 30 min are gained. In addition, it is stated that the centrifuge time of the Barricor tube can be shorter (i.e., 3 min at 4,000 *g*) [6, 11, 12]. In addition, problems such as clogging of the analyzer probe, improper sample aspiration, inappropriate test results may occur due to fibrin and/or gel-related reasons, which may prolong the TAT. The usage of Barricor tube can shorten TAT by excluding these problems.

One study reported that the usage of the Barricor tube improved the percentage of results achievable within 90 min by >90% [13].

In another study assessed the effects of usage of the Barricor tube in a stat laboratory, the median TAT reduced from 45 to 38 min, and the ration of a TAT >60 min diminished from 7.84 to 2.66%, which is approximately one-third that for SST [14].

Also in other studies, it was reported that Barricor tubes provided a higher centrifugation speed and reduced centrifugation time [3, 15].

Hence, in this study, it was aimed to compare the Barricor tube and SST in outpatients and outpatient oncology patients over timely biochemistry parameters which TAT is important.

Otherwise, according to the recommendation of the European Federation of Clinical Chemistry and Laboratory Medicine (EFLM) Working Group for Preanalytical Phase (WG-PRE), a laboratory should apply technical and clinical verification/validation when starting a new tube. The CLSI GP34 guideline also recommends that the hospital make its own assessment of tube replacement [16, 17].

In this study, we planned to use Barricor tube in both routine outpatients and outpatient oncologic patients. The reason why we preferred oncology patients was that the probability of hemolysis increases with centrifugation time, and we made such a choice in order to give fast and accurate results in these patients and to eliminate the possibility of redrawing blood [3]. For this purpose, we compared the Barricor tube (BD Vacutainer® Barricor™ LH Plasma Tubes) and the currently used SST (BD Vacutainer® Serum Separator Tubes™ II Advance Plus) in these patients set on the parameters studied in the emergency.

Materials and methods

Participants

The study was conducted between May 2020 and June 2020 after the decision of the local Ethics Committee of Istanbul Training and Research Hospital (Decision Date & Number: May 22, 2020/2341). All participants provided written informed consent.

In the study, two groups were evaluated: outpatient clinic patients and outpatient oncology patients. Biochemical tests for which rapid TAT was important, were evaluated in these groups. In our hospital, blood samples were drawn from outpatient oncology patients in the morning and according to the test results, they received chemotherapy treatment on the same day. The parameters evaluated purposed decreasing the TAT, although not specific to the oncology test. For this reason, outpatient oncology patients were included in the study. It was included 36 outpatient clinic patients and 16 outpatient oncology patients. All volunteers were between 18 and 65 years old and were randomly selected. The results of 18 parameters [albumin, amylase, alkaline phosphatase (ALP), alanine aminotransferase (ALT), aspartate aminotransferase (AST), total bilirubin (Tbil), urea, calcium (Ca), chloride (Cl), creatinine kinase (CK), creatine kinase–MB fraction mass (CK–MB mass), creatinine (Crea), gamma–glutamyl transferase (GGT), glucose, potassium (K), lactate dehydrogenase (LD), lipase, sodium (Na)] in patients were included in the study. If any measurement result was below the limit of detection (LoD), it was excluded from the assessment. The patients who applied to the blood collection clinics were included in the study. All volunteers were rested in a sitting position before blood collection. Tourniquet application time did not exceed 1 min. After 8–12 h of fasting at night, blood was drawn into the tubes by an experienced phlebotomist between 08:00 and 10:00 a.m. It was ensured that all tubes were filled within the fill volume level by an observer as per recommended CLSI GP 41 [18]. According to the CLSI GP34-A standard, the order of control and comparative tubes were randomized during blood collection [17]. During routine blood collection, serum separator tubes (SST, BD Vacutainer, SST™ II Advance, 13 × 100 mm, 5.0 mL, catalog number: 367,955) and Barricor tubes, which are the plasma separator tubes with mechanical separators (BD Vacutainer Barricor™ LH Plasma, 13 × 100 mm, 5.0 mL, catalog number: 368,051, lot number: 0,062,091) were used. The holder (BD

Vacutainer® Holder, Beckton, Dickinson and Company, FL, NJ, USA) was used as the blood collection device. The 21G BD Vacutainer® Eclipse (BD-Belliver Industrial Estate, Plymouth PL6 7BP UK) was used as a needle.

All tubes were stored at room temperature (20–25 °C) in an upright position and centrifuged using an Allegra X-15R Benchtop Centrifuge (Beckman Coulter®) according to the manufacturer's instructions.

Methods

18 biochemistry parameters, albumin (g/dL), amylase (U/L), ALP (U/L), ALT (U/L), AST (U/L), Tbil (mg/dL), urea (mg/dL), Ca (mg/dL), CK (U/L), Crea (mg/dL), GGT (U/L), glucose (mg/dL), LD (U/L), lipase (U/L) were measured by photometric method and Na (mmol/L), K (mmol/L), Cl (mmol/L) were measured by ion selective electrode (ISE) module using the AU2700 autoanalyser (Beckman Coulter Inc., CA, USA). CK-MB mass (ng/mL) was analyzed by chemiluminescence assay method using the Beckman Coulter Access immunoanalyser (Beckman Coulter Inc., CA, USA). All parameters were measured within the same run. All analyses were performed in duplicate and the averages of the results were evaluated. Calibration and internal quality control (Beckman Coulter Ireland Inc.) were performed just before the study.

Statistical analysis

Since the number of samples was below 50, the suitability of the results to the normal distribution was evaluated with the Shapiro-Wilk test. The results are presented according to their distribution: average value and standard deviation (SD) for normally distributed parameters or median value and 1st – 3rd quartiles for non-normally distributed parameters. Paired sample t-test or Wilcoxon test was used to evaluate the statistically significant differences between the two dependent groups. Bland-Altman plots analysis was applied.

Bias, coefficient of variation (CV) and total error were calculated using the following formulas, respectively: Bias%=[Compared tube (Barricor tube) – Reference tube (SST)] × 100/Reference tube (SST), where SST represents the reference tube and Barricor the compared tube. Average of all calculated results differences between the reference and comparison tube for each analyte represents the mean bias. CV% was calculated by working in duplicate from the Barricor tubes. CV% =(Standard deviation/mean) × 100. Total Error%=Bias% + 1.65 × CV%. Total error, bias values were evaluated according to the total allowable error (TEa), desirable bias values in the Westgard database [19]. p was determined using the Wilcoxon or Paired sample t-test and p value less than 0.05 ($p<0.05$) was considered statistically significant. Statistical analyses were carried out with MedCalc software (v.20.115) and SPSS (v.22.0) for Windows.

Results

Table 1 demonstrates descriptive statistics and comparison results for Barricor tube and SST for 18 parameters (Albumin, Amylase, ALP, ALT, AST, Tbil, Urea, Ca, Cl, CK, CK-MB mass, Crea, GGT, Glucose K, LD, Lipase and Na) evaluated in outpatient clinic patients. Among these parameters, 10 parameters (Albumin, Amylase, ALP, ALT, Tbil, Ca, CK, CK-MB mass, GGT and K) showed statistically significant differences ($p<0.05$).

Table 1: Descriptive statistics and comparison results for Barricor tube and SST in outpatient clinic patients.

Parameter, unit	n	Barricor tube	SST	p-Value	Bias%	Desirable bias, %[a]
Alb, g/dL	36	4.45 (4.20–4.60)	4.50 (4.20–4.60)	**0.014**	−0.51	1.43
Amy, U/L	36	83.5 (69.0–97.6)	83.5 (70.6–99.3)	**0.004**	−0.80	7.40
ALP, U/L	36	71.0 (60.5–86.5)	72.0 (62.0–89.0)	**<0.001**	−2.65	6.72
ALT, U/L	36	20.5 (14.0–31.0)	21.0 (14.0–31.5)	**0.025**	−1,62	11.48
AST, U/L	36	21.5 (17.0–25.0)	22.0 (17.5–25.5)	0.632	1.90	6.54
Tbil, mg/dL	36	0.63 (0.52–0.91)	0.62 (0.53–0.93)	**0.050**	−0.87	8.95
Urea, mg/dL	36	14.6(11.3–18.7)	14.7 (11.2–18.8)	0.563	−0.23	5.57
Ca, mg/dL	36	9.39 ± 0.38	9.44 ± 0.40	**0.007**	−0.57	0.82
Cl, mmol/L	36	102.3 ± 3.06	102.2 ± 3.14	0.373	0.09	0.50
CK, U/L	36	111 (71.5–174)	114 (73–175.5)	**<0.001**	−1.50	11.5
CK-MB mass, ng/mL	20	2.55 (1.35–3.55)	2.35 (1.35–3.45)	**0.012**	2.95	14.88
Crea, mg/dL	36	0.86 (0.75–1.06)	0.86 (0.75–1.07)	0.509	0.31	3.96
GGT, U/L	36	25 (16.5–52)	26 (18.5–54)	**<0.001**	−5,35	11.06
Glu, mg/dL	36	98 (91–134.5)	98 (91–134.5)	0.299	−0.20	2.34
K, mmol/L	36	4.17 ± 0.37	4.38 ± 0.37	**<0.001**	**−4.94**	1.81
LD, U/L	36	173.5 (153–205)	170 (151.5–211.5)	0.396	0.78	4.30
Lip, U/L	36	18.5 (15–35.5)	18.5 (14.5–35.5)	0.294	0.49	11.31
Na, mmol/L	36	138 (136–139)	138 (136–139)	0.208	0.14	0.23

Bold numbers indicate percent bias exceeding the desirable bias limit or statistically significant differences. SST, serum separator tube; Alb-albumin; Amy-amylase; ALP, alkaline phosphatase; ALT, alanine transaminase; AST, aspartate transaminase; Tbil, total bilirubin; Ca, calcium; Cl, chloride; CK, creatine kinase; CKMB, creatine kinase isoenzyme MB; Crea, creatinine; GGT, gamma-glutamyl transferase; Glu, glucose; K, potassium; LD, lactate dehydrogenase; Lip, lipase; Na, sodium. [a][19].

Table 2: In outpatient clinic patients, comparison of parameters, which have statistically significant differences for Barricor tube vs. SST, with TEa and desirable CV.

Parameter, unit	CV, %	Desirable CV, %[a]	Total error, %	Total allowable error, %[a]
Alb, g/dL	0.98	1.6	2.13	4.07
Amy, U/L	1.17	4.4	2.73	14.6
ALP, U/L	2.23	3.23	6.33	12.04
ALT, U/L	1.75	9.7	4.51	27.48
Tbil, mg/dL	0.9	10.90	2.36	26.94
Ca, mg/dL	0.68	1.05	1.69	2.55
CK, U/L	0.75	11.4	2.74	30.3
CK-MB mass, ng/mL	3.36	9.2	8.49	30.06
GGT, U/L	3.52	6.7	11.16	22.11
K, mmol/L	0.91	2.3	**6.44**	5.61

Bold number indicates total error exceeding the total allowable error. Alb, albumin; Amy, amylase; ALP, alkaline phosphatase; ALT, alanine transaminase; Tbil, total bilirubin; Ca, calcium; CK, creatine kinase; CKMB, creatine kinase isoenzyme MB; GGT, gamma-glutamyl transferase; K, potassium. Average of all calculated results differences between the reference (SST) and comparison tube (Barricor tube) for each analyte represents the mean bias. CV (coefficient of variation) % was calculated by working in duplicate from the Barricor tubes. The criteria for desirable bias%, desirable CV % and total allowable error (%) were obtained from the Westgard biological variation database [a][19].

CV (%), desirable CV (%), total error (%), and TEa (%) values are presented for 10 parameters (Albumin, Amylase, ALP, ALT, Tbil, Ca, CK, CK-MB mass, GGT and K) where the differences between Barricor tube and SST were significant (Table 2). The CV values of all of these parameters were within the desirable CV. While the bias% for K was more than desirable bias [bias (%)>desirable bias (%) –4.94>1.81], all the other parameters were within desirable bias. While the total error for K was more than TEa, all the other parameters were within TEa [Barricor tube K: 4.17 ± 0.37, SST K: 4.38 ± 0.37 and total error (%) >TEa (%) 6.44>5.61].

On the other hand, Table 3 demonstrates descriptive statistics and comparison results for Barricor tube and SST for 18 parameters (Albumin, Amylase, ALP, ALT, AST, Tbil, Urea, Ca, Cl, CK, CK-MB mass, Crea, GGT, Glucose, K, LD, Lipase, and Na) evaluated in outpatient oncology patients. Among 3 parameters (ALP, GGT and K) with statistically significant differences ($p<0.05$).

CV (%), desirable CV (%), total error (%), and TEa (%) values are presented for these three parameters (ALP, GGT and K) wherein the Barricor tube and SST had significant differences (Table 4). CV values of all parameters with the statistically significant differences in outpatient oncology patients were within the desirable CV. While the bias% for K was more than desirable bias [bias (%)>desirable bias (%) –5.95>1.81], all the other parameters were within desirable bias. Moreover, the total error was more than TEa only for K, and other parameters were within TEa [Barricor tube K: 4.14 ± 0.31, SST K: 4.42 ± 0.45 and total error (%)>TEa (%) 7.45>5.61] (Tables 3 and 4).

Table 3: Descriptive statistics and comparison results for Barricor tube and SST in outpatient oncology patients.

Parameter, unit	n	Barricor tube	SST	p-Value	Bias%	Desirable Bias, %[a]
Alb, g/dL	16	4.34 ± 0.40	4.35 ± 0.43	0.669	–0.10	1.43
Amy, U/L	16	65 (50.5–77.5)	65 (52–78.5)	0.688	–0.42	7.4
ALP, U/L	16	69.8 ± 14.7	72.2 ± 15.5	**<0.001**	–3.20	6.72
ALT, U/L	16	21.8 ± 13.1	22.0 ± 13.1	0.164	–1.28	11.48
AST, U/L	16	20.5 (15–30)	19.5 (17–29)	0.489	–0.92	6.54
Tbil, mg/dL	16	0.68 (0.51–0.83)	0.70 (0.54–0.83)	0.273	–0.84	8.95
Urea, mg/dL	16	14.5 ± 4.32	14.6 ± 4.46	0.273	–0.34	5.57
Ca, mg/dL	16	9.41 ± 0.35	9.41 ± 0.36	0.876	–0.10	0.82
Cl, mmol/L	16	103 (101.5–104)	103.5 (102–104.5)	0.055	–0.37	0.50
CK, U/L	16	72.5 (39.5–130.5)	73.5 (39–129)	0.303	0.50	11.5
CK-MBmass, ng/mL	10	1.45 (1.2–3.3)	1.45 (1.2–3.3)	0.078	2.42	14.88
Crea, mg/dL	16	0.85 ± 1.20	0.86 ± 1.20	0.456	–0.47	3.96
GGT, U/L	16	18.5 (15–31.5)	19(15.5–32)	**0.009**	–4.67	11.06
Glu, mg/dL	16	94.5 (85.5–123.5)	95.5 (88–121.5)	0.121	–1.03	2.34
K, mmol/L	16	4.14 ± 0.31	4.42 ± 0.45	**0.002**	**–5.95**	1.81
LD, U/L	16	166 (155.5–202.5)	164(147–209.5)	0.404	1.17	4.30
Lip, U/L	16	18 (13.5–33.5)	18.5 (14.0–33.0)	0.496	–2.29	11.31
Na, mmol/L	16	138 (137–139)	138.5 (137–139)	0.813	0.05	0.23

Bold numbers indicate percent bias exceeding the desirable bias limit or statistically significant differences. SST, serum separator tube; Alb, albumin; Amy, amylase; ALP, alkaline phosphatase; ALT, alanine transaminase; AST, aspartate transaminase; Tbil, total bilirubin; Ca, calcium; Cl, chloride; CK, creatine kinase; CKMB, creatine kinase isoenzyme MB; Crea creatinine; GGT, gamma-glutamyl transferase; Glu, glucose; K, potassium; LD, lactate dehydrogenase; Lip, lipase; Na, sodium. [a][19].

Table 4: In outpatient oncology patients, comparison of parameters, which have statistically significant differences for Barricor tube vs. SST, with TEa and desirable CV.

Parameter, unit	CV, %	Desirable CV, %[a]	Total error, %	Total allowable error, %[a]
ALP, U/L	2.23	3.23	6.90	12.04
GGT, U/L	3.52	6.7	10.48	22.11
K, mmol/L	0.91	2.3	**7.45**	5.61

Bold number indicates total error exceeding the total allowable error. ALP, alkaline phosphatase; GGT, gamma-glutamyl transferase; K, potassium. Average of all calculated results differences between the reference (SST) and comparison tube (Barricor tube) for each analyte represents the mean bias. CV (coefficient of variation) % was calculated by working in duplicate from the Barricor tubes. The criteria for desirable bias%, desirable CV% and total allowable error (%) were obtained from the Westgard biological variation database [a][19].

Bland-Altman plots were given for parameters with significant p values for outpatient clinic patients and outpatient oncology patients (Figure 1).

Discussion

Serum and plasma are common specimens in biochemistry laboratories, but it was stated in the literature that plasma demonstrates the *in vivo* situation more accurately [6, 20, 21].

On the other hand, there are some differences between them. In order to obtain serum, waiting time is required for blood clotting. In addition, clotting time can be prolonged in some pathological conditions such as high-dose anticoagulant treatment, thrombolytic therapy, or the presence of cryoglobulins. The improper clotting develops generally due to the short waiting time, but may also be due to prolonged clotting in conditions such as anticoagulant therapy and this situation can produce fibrin in the serum. Fibrin might cause various problems: improper separation of serum, obstruction of analyzers sample aspiration probe, distortion the serum volume sampled by the analyzer, inaccurate results in tests such as sensitive immunoassay. Also, incomplete clotting promotes the lysis of red blood cell, and the resulting hemolysis affects sensitive tests [5, 22]. These serum-related situations also cause delay of TAT.

The difficulties mentioned that in the serum can be overcome by switching to heparinized plasma instead of serum. Plasma has many advantages. Heparinized plasma tubes can be centrifuged after the blood collection without waiting and this saves time. From the same volume of drawned blood sample, more volume can be obtained in plasma than in serum. Since it is an anticoagulant in heparinized plasma tubes, coagulation-induced interferences are precauted. In addition, the fibrin problem that occurs in the serum, does not occur in the plasma sample [6, 23].

Moreover, pseudohyperkalemia, described as false increase in measured potassium level can be seen in serum tubes due to thrombocytosis and leukocytosis. In this case, the plasma tube with lithium heparin can be chosen as the solution [24–27].

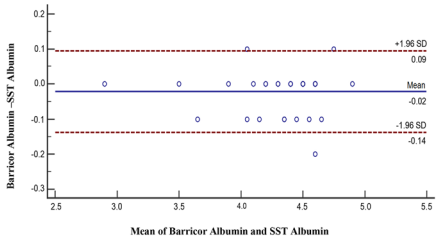
On the other hand, Barricor tubes have some advantages compared gel separated heparinized tubes. It was reported that the Barricor tubes provided a plasma sample with greater analyte stability, less cellular contamination, no gel artifacts, and were more resistant to temperature changes during transportation compared with lithium-heparin gel tubes [5, 28–30].

The blood collection unit of our hospital consists of two departments: the outpatient department and the blood collection unit for oncology patients, which was organized to ensure faster results. The outpatient oncology patients gave a blood sample in the morning and get chemotherapy treatment according to the test result. Therefore, biochemical parameters aimed at shortening the TAT were evaluated, although not specific to the oncology test. To the end that, we aimed to compare the Barricor tube and SST in outpatient clinic and outpatient oncologic patients set on the tests measured in the emergency.

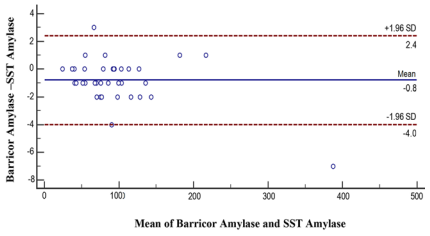
Although Barricor tube studies were mostly performed on samples taken from healthy participants, there were also studies with participants such as inpatients, intensive care patients, and hemodialysis patients [3, 14, 31–34]. In the present study, the comparison between Barricor tube and SST was made in outpatient clinic patients and outpatient oncology patients.

In our study, we found a significantly lower K level in Barricor tube than SST in both outpatient clinic patients and outpatient oncology patients (Tables 2 and 4). This result was compatible with previous studies [13, 31, 32]. This study confirms previous knowledge in the literature that potassium values are higher in serum than in plasma. This situation was attributed to the release of K from platelets during aggregation and degranulation in the clotting process [32, 35, 36]. At the same time, in the literature, it is reported that heparinized plasma can be widely used for biochemical tests. Also, the studies stated that serum and plasma were specimens that could be used interchangeably [6, 37].

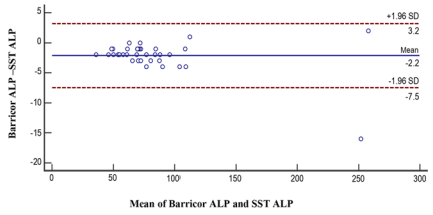
Furthermore, for the LD parameter, the studies comparing the Barricor tube with SST or plasma separator tube (PST) reported negative bias in the Barricor tube [3, 31], while the another study reported positive bias [35]. In our



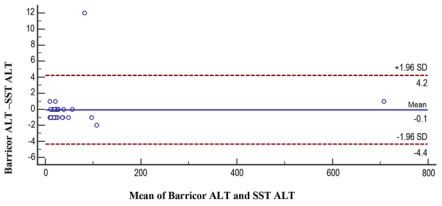
A. Albumin in Outpatient Clinic Patients



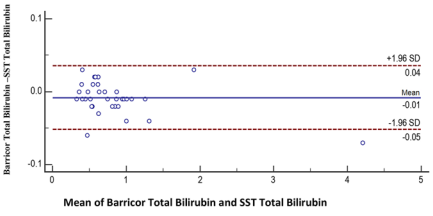
B. Amylase in Outpatient Clinic Patients



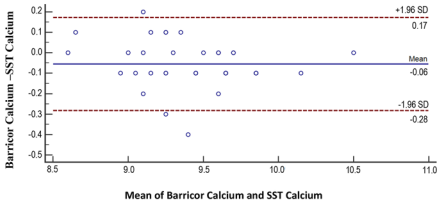
C. ALP in Outpatient Clinic Patients



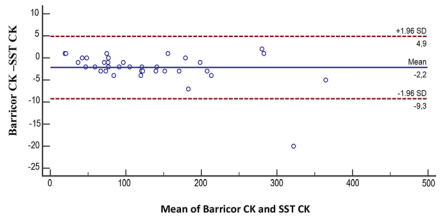
D. ALT in Outpatient Clinic Patients



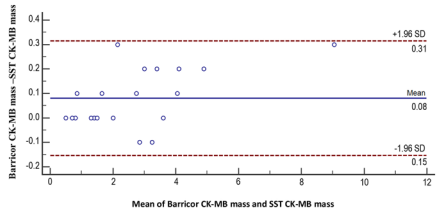
E. Total Bilirubin in Outpatient Clinic Patients



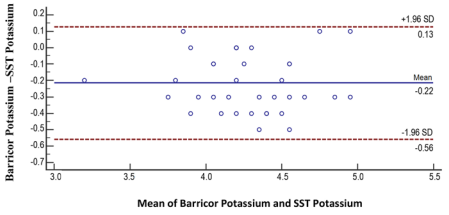
F. Calcium in Outpatient Clinic Patients



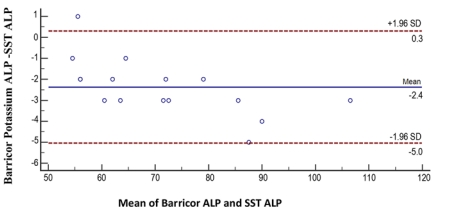
G. Creatine Kinase (CK) in Outpatient Clinic Patients



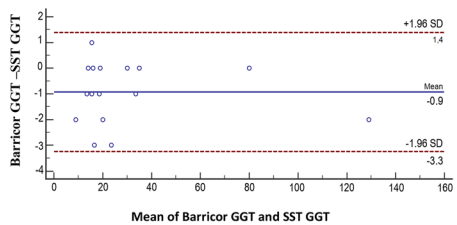
H. CK-MB mass in Outpatient Clinic Patients



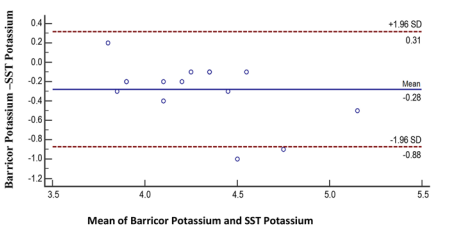
I. Potassium in Outpatient Clinic Patients



J. ALP in Outpatient Oncology Patients



K. GGT in Outpatient Oncology Patients



L. Potassium in Outpatient Oncology Patients

Figure 1: Bland–Altman plots for parameters with significant p-values.

study, no significant difference was observed for LD between Barricor tube and SST.

The AST value was reported lower in the Barricor tube in a study comparing the Barricor tube with the SST [31], but another study reported it as high [35]. In our study, there was no significant difference between Barricor tube and SST for the AST test.

The studies comparing Barricor tube with SST or rapid serum tube (RST) reported higher total protein values in Barricor tubes [14, 32, 35]. There was no total protein in the parameters we evaluated in our study, but we evaluated albumin and there was no significant difference.

Also, the one study stated slightly higher levels for phosphorus (P) and high-density lipoprotein cholesterol (HDL) in the Barricor tube compared to SST [14]. These parameters were not evaluated in our study.

While the studies reported that glucose values were lower in serum than plasma [31, 38, 39], the other study reported negative bias for Barricor tube [35]. In our study, no bias was observed for glucose.

Consequently, in most studies, clinical performance for most biochemical analytes was acceptable compared to the Barricor tube and SST (or different tubes) [14, 31, 32, 35]. The results of our study were also compatible with this situation. In addition, considering the advantages of the Barricor tube and thus the obtained plasma [4, 5, 14, 30, 40–43], the usage of the Barricor tube could be useful in laboratory.

Our study comparing Barricor and SST, was compatible with previous studies, and although K exceeded TEa, other parameters were concordant in both outpatient clinic and outpatient oncology patients in the evaluated analytes.

Some studies recommend reference range changes for some analytes when using a Barricor tube [17, 35]. In this context, we think that further studies might be required.

Limitations

This study has some limitations. According to the CLSI GP 34A guideline, it is recommended that minimum of 20 subjects [17]. In present study, while this number was complied in outpatients, the number of subjects in oncology patients was less. Another limitation of this study was being single-center. In further study, with more participants and multi-centered study might be done.

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Competing interests: Authors state no conflict of interest.

Informed consent: Informed consent was obtained from all individuals included in this study.

Ethical approval: Ethics Committee of Istanbul Training and Research Hospital (Decision Date & Number: May 22, 2020/2341).

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