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Research Article /Araştırma

Acil servise başvuran hastalarda enjektör ve damar yolu adaptörü ile kan alma işleminin hemoliz ve test sonuçları açısından karşılaştırılması

Comparison of blood collection with injector and venipuncture adapter in terms of hemolysis and test results in patients applying to the emergency department

Ahmet Rıfat Balık[1], Çiğdem Yücel[1], Erdim Sertoğlu[1], Ertan Cömertpay[2], Taner Özgürtaş[1]

[1]Assoc. Prof. Dr. Ahmet Rifat Balik, Health Sciences University Gulhane Training and Research Hospital Medical Biochemistry Laboratory, Ankara/Turkey. E-mail: rifatbalik@hotmail.com, ORCID ID: 0000-0002-3893-9721

[1]Assoc. Prof. Dr. Cigdem Yucel, Health Sciences University Gulhane Training and Research Hospital Medical Biochemistry Laboratory, E-mail: yucelcigdem80@gmail.com, ORCID ID: 0000-0003-2647-440X

[1]Prof. Dr. Erdim Sertoğlu, Health Sciences University Gulhane Training and Research Hospital Medical Biochemistry Laboratory, E-mail: erdimsertoglu@gmail.com, ORCID ID: 0000-0002-4414-9224

[2]Dr. Ertan Comertpay, Health Sciences University Gulhane Training and Research Hospital, Department of Emergency Medicine, Ankara/Turkey. E-mail: ertancomertpay@gmail.com, ORCID ID: 0000-0002-8648-5963

[1]Prof. Dr. Taner Ozgurtas, Health Sciences University Gulhane Training and Research Hospital Medical Biochemistry Laboratory, E-mail: chem352000@yahoo.com, ORCID ID: 0000-0003-1110-6671

ABSTRACT

Aim: Injector blood collection has been identified as the main cause of in vitro hemolysis. Blood collection with a venipuncture adapter has been associated with potential benefits in reducing hemolysis rates during blood collection. In our study, we aimed to compare the number of hemolyzed samples and the parameters most affected by hemolysis between the two methods.

Materials and Methods: Two tubes of blood were collected from the volunteer participants who applied to the emergency department, one with a syringe and one with an intravenous adapter. Serum samples of 100 patients were divided into two groups as injector and intravenous adapter blood samples and analyzed by spectrophotometric method under the same conditions. Hemolysis rates and results of hemolysis-affected tests were compared for both groups.

Results: The total hemolysis rate and the number of tests affected by hemolysis were significantly higher in samples collected with the syringe than in those collected with the venipuncture adapter ($p<0.001$ for both). Total protein ($p=0.018$), urea ($p=0.031$), lactate dehydrogenase ($p=0.001$), aspartate aminotransferase ($p<0.001$), alanine aminotransferase ($p=0.001$) and potassium ($p=0.004$) levels were significantly higher in the injector group, while sodium ($p=0.006$) level was significantly higher in the vascular access adapter group.

Conclusions: The use of appropriate venipuncture adapters instead of syringes in emergency departments may have significant implications for laboratory test safety and quality. It is important for healthcare professionals to consider the potential impact on hemolysis rates, patient comfort and reliability of analytical results when choosing the most appropriate blood collection method.

ÖZ

Amaç: Enjektörle kan alma, in vitro hemolizin ana nedeni olarak tanımlanmıştır. Damar yolu adaptörü ile kan alma, kan alma sırasında hemoliz oranlarını azaltmada potansiyel faydalarla ilişkilendirilmiştir. Çalışmamızda, iki yöntem arasında hemolizli numune sayısını ve hemolizden en çok etkilenen parametreleri karşılaştırmayı amaçladık.

Gereç-Yöntem: Acil servise başvuran gönüllü katılımcılardan biri enjektörle diğeri intravenöz adaptörle olmak üzere iki tüp kan alınmıştır. Toplam 100 hastanın serum örnekleri enjektör ve intravenöz adaptör kan örnekleri olarak iki gruba ayrılmış ve aynı koşullar altında spektrofotometrik yöntemle analiz edilmiştir. Hemoliz oranları ve hemolizden etkilenen testlerin sonuçları her iki grup için karşılaştırılmıştır.

Bulgular: Toplam hemoliz oranı ve hemolizden etkilenen test sayısı enjektör ile alınan numunelerde damar yolu adaptörü ile alınanlara kıyasla önemli ölçüde daha yüksekti (her ikisi için de $p<0,001$). Total protein ($p=0,018$), üre ($p=0,031$), laktat dehidrogenaz ($p=0,001$), aspartat aminotransferaz ($p<0,001$), alanin aminotransferaz ($p=0,001$) ve potasyum ($p=0,004$) düzeyleri enjektör grubunda, sodyum ($p=0,006$) düzeyi ise damar yolu adaptörü grubunda anlamlı olarak daha yüksekti.

Sonuç: Acil servislerde enjektör yerine uygun damar yolu adaptörlerinin kullanılmasının laboratuvar testlerinin güvenliği ve kalitesi üzerinde önemli etkileri olabilir. Sağlık çalışanlarının en uygun kan alma yöntemini seçerken hemoliz oranları, hasta konforu ve analitik sonuçların güvenilirliği üzerindeki potansiyel etkiyi göz önünde bulundurmaları önemlidir.

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DOI: 10.5281/zenodo.14774718
Corresponding Author/Sorumlu Yazar: Rıfat Balık
E-mail: ahmetrbalik@gmail.com
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INTRODUCTION

Laboratory tests have critical role in the diagnosis and management of various medical conditions. They are used not only in the determination of disease ethiology and monitoring the prognosis of diseases bur are also necessary in guiding treatment decisions and evaluation of responses to given treatments (1). Laboratory tests also contribute to the detection of high risk patients and determination of the potential benefits of certain treatments (2). As they influence nearly 70 % of medical decisions, the accuracy and the actuality of laboratory test results are very important and critical in patient management (3).

Generally, laboratory test are carried out with blood samples as they give precios diagnostic data for a variety of medical situations. Blood tests are necessary fort he evaluation of different health parameters like complete blood count, blood coagulation, thrombocyte function and hemoglobin levels (4, 5). Besides these, blood samples are used in detection of infectious disease like HIV and cancer biomarkers (6, 7). Blood tests are also crucial for diagnosis and treatment of dehydration and gastroenteritis (8). But it should be kept in mind that excessive blood sampling may contribute to settlement of anemia and need for blood transfusion especially in critical patients (9, 10). Excessive blood loss caused by blood sampling is especially a matter of concern in the intensive care units (ICU) which may affect patient results (9, 11). For this reason; efforts for minimizing blood loss caused by blood sampling for laboratory tests and application of convenient blood sampling methods and reducing unnecessary test is highly important in terms of patient security and care (9, 10 ,11).

Blood sampling with a syringe is defined as the major cause of in vitro hemolysis; and this situation can be worsened by the prolonged and increased vacuum and liquid tension caused by primary blood sampling tubes (12). Hemolysis is a major challenge in the clinical laboratory as it causes problems in acceptance and rejection of samples and causes erraneous results in critical blood parameters like potassium, urea and HbA1c. (13, 14, 15, 16, 17). The impact of hemolysis on the quality of blood components and the biophysical properties of red blood cells has been investigated, highlighting the need for careful consideration of sample handling and storage to minimize hemolysis (18). It is important for healthcare professionals to be aware of the potential impact of hemolysis on laboratory test results and to use appropriate blood sampling techniques to minimize the occurrence of this situation.

Collection of blood with a vascular access adapter has been associated with potential benefits (19, 20). These vascular access devices offer the advantage of fewer needle punctures and patient discomfort, while also minimizing the risk of hemolysis and improving the quality of blood samples analyzed by the laboratory. These findings suggest that the use of vascular access adapters for blood collection can contribute to improving sample quality by reducing hemolysis rates, thereby increasing the accuracy of laboratory analyzes and providing better patient care.

It is known that teh hemolysis rates are quite high in blood samples accepted to clinical laboratories from emergency service. Recently, Greiner Bio-One has developed a new vascular access adapter (VACUETTE® SAFELINK, Greiner Bio One GmbH, Kremsmuenster, Austria) which provides an easier and quicker way of blood sampling with practical use. In the present study we planned to compare the adapter in question

with the standard blood collection method used in our hospital's emergency department. Thus, we aimed to evaluate and compare the number of hemolyzed samples between the two methods and the parameters most affected by hemolysis.

MATERIALS AND METHODS

A total of 100 volunteer participants who applied to our hospital's emergency department were included in the study. Participants were randomly selected from adult patients presenting to the emergency department yellow area. The study has been approved by the local ethics committee (06.04.2022/14). Two blood samples were obtained form each participant; one with a syringe an done with a vascular access adapter (VACUETTE® SAFELINK, Greiner Bio One GmbH, Kremsmuenster, Austria) (Figure 1). These samples were simultaneously accepted by the clinical biochemistry laboratory of our hospital and centrifuged at the same batch at 4000 rpm for 10 minutes to seperate sera. The seperated sera from 100 volunteers were divided into two groups accordingly due to collection procedure even with a syringe or an adapter.

Figure 1. Blood collection procedure with a vascular access adapter

200 serum samples were analyzed by spectrophotometric method under the same conditions with Beckman Coulter AU680 autoanalyzer in the biochemistry laboratory of our hospital. Hemolysis indices of sera and a panel of 12 parameters were analyzed. The results obtained were recorded and evaluated statistically. Hemolysis rates and results of tests affected by hemolysis were compared for both groups.

Table 1. LIH (lipemia/turbidity, icterus and hemolysis) kit hemolysis indices

HEM approximate concentration (Beckman Coulter LIH reagent)		LIH index decision limits
Flag	**HEM (mg/dL Hemoglobin)**	**Hemolysis index**
N	< 50	
+	50-99	0.17
++	100-199	0.35
+++	200-299	0.7
++++	300-500	1.0
+++++	>500	1.7

Homolysis indices of the sera were analyzed by using the Beckman Coulter LIH (lipemia/turbidity, icterus and hemolysis) kit. Accordingly, approximate hemolysis indices were calculated using the table data below (Table 1).

Apart from the hemolysis index, total protein, sodium, urea, lipase, lactate dehydrogenase (LDH), aspartate aminotransferase (AST), alanine aminotransferase (ALT), potassium,

magnesium, total bilirubin, total cholesterol and triglyceride parameters were also analyzed and compared.

RESULTS

According to the results obtained, hemolysis was observed in eight (8%) of the blood samples taken using the vascular access adapter, while 26 of the total 1200 tests analyzed were affected from hemolysis (2.2%). Hemolysis occurred in 47 (47%) of the blood samples taken with the syringe and 161 tests were affected by hemolysis (13.4%). Accordingly, it was determined that the total hemolysis rate and the number of tests affected by hemolysis were significantly higher in samples taken with a syringe than in those taken with a vascular access adapter ($p<0.001$ for both).

The distribution of parameters affected by hemolysis and the number of patients in both groups are presented in Table 2.

Table 2. Distribution of parameters affected by hemolysis and the number of patients

Parameters affected by hemolysis	Vascular access adapter	Syringe
LDL	8 (0.67 %)	47 (3.92 %)
AST	8 (0.67 %)	47 (3.92 %)
Total bilirubin	8 (0.67 %)	47 (3.92 %)
Magnesium	2 (0.17 %)	14 (1.17 %)
Total Protein		4 (0.33 %)
Cholesterol		2 (0.17 %)
Number of patients affected by hemolysis	**Vascular access adapter**	**Syringe**
1+	6 Patients (6 %)	33 (33 %)
2+	2 Patiants (2 %)	10 (10 %)
3+		2 (2 %)
4+		2 (2 %)

LDL: lactate dehydrogenase , AST: aspartate aminotransferase

The blood samples of eight patients in the group taken with a vascular access adapter was also affected by hemolysis in the group taken with a syringe. Therefore, all patients affected by hemolysis were excluded in both groups for correct comparison of measured parameters. The parameters measured with the blood samples of the remaining 53 patients were evaluated. As a result of

Table 3. Parameters with significant differences as a result of comparison of all patient samples

Parameter	Vascular access adapter	Syringe	p values
Total Protein (g/dL)	7.02 ± 0.50	7.20 ± 0.49	0.018
Urea (mg/dL)	26.50 (7-78)	30 (9-76)	0.031
LDH (U/L)	186 (108-602)	208 (113-634)	0.001
AST (U/L)	18 (12-501)	22 (13-49)	<0.001
ALT (U/L)	15 (1-344)	18 (8-515)	0.001
Potassium (mmol/L)	4.13 (3.05-5.59)	4.27 (2.72-6.23)	0.004
Sodium (mmol/L)	139 (124-145)	138 (127-151)	0.006

LDL: lactate dehydrogenase , AST: aspartate aminotransferase, ALT: alanine aminotransferase. "p<0.05" is considered statistically significant. Significant p values are marked in bold.

the comparison, no statistically significant difference was observed in any parameter between the blood of patients not affected by hemolysis in both groups.

Then, the blood parameters of 47 patients affected by hemolysis were compared in both groups. The results have revealed that urea and AST levels were significantly higher in the groupin which blood samples were collected by syringe (p values: 0.039 and 0.022, respectively). There was no significant difference between other parameters among two groups.

Finally, all patient blood samples were compared and the parameters with significant differences are presented in Table 3.

As a result total protein, urea, LDH, AST, ALT and potassium levels were significantly higher in the group administered via syringe, while sodium levels were significantly higher in the group administered via vascular access adapter.

DISCUSSION

Comparison of blood collection with a syringe versus an intravenous line adapter in terms of laboratory safety and quality is a critical issue for healthcare professionals. The choice of blood collection method can significantly affect the accuracy of laboratory analyzes and patient care. Venipuncture is the most common invasive procedure for inpatients, highlighting the importance of ensuring the safety and quality of this process (21). Studies have also shown that blood collection through a persistant intravenous catheter can prevent repeated venipunctures, and minimize the risk of thrombophlebitis, anxiety, and pain in these patients (22). In terms of laboratory test safety and quality, the choice of blood collection method may also affect the reliability of results. For example, plasma concentrations of certain analytes, such as free metanephrines and catecholamines, have found to be higher in blood samples obtained by venipuncture compared to those use collected by a canulla (23). This shows that the choice of blood collection method can influence analytical results and subsequent clinical interpretations.

Laboratory tests that are adversely affected by blood collection by syringe include bilirubin, blood gas, and activated platelet tests. In the newborns, hemolysis caused by syringe use during blood collection may affect the accuracy of plasma bilirubin measurements and potentially affect the prevention of neonatal kernicterus (24). Blood gas testing can be affected by hemolysis due to alcohol containing disinfectants, small-diameter needles, narrow catheters, and excessive pressure caused by the syringe, leading to diagnostic errors (25). Besides this; assessment of platelet activation by flow cytometry has shown to be affected by blood collection technique, with differences observed between samples drawn in vacuum tubes and by syringe (26). The presence of hemolysis in blood samples collected with a syringe may require repeated sampling, which may lead to additional costs, delays in diagnosis, and discomfort for the patient. Hemolysis can also affect the accuracy of laboratory tests like glucose, pH, and sodium, as well as it is a source of interference with clinical chemistry and hematological tests (27, 28). Additionally, the use of syringes to draw blood has been associated with variability in fill volume; which may lead to iatrogenic blood loss and affects the accuracy of blood gas measurements (29). The presence of hemolysis due to syringe use can lead to diagnostic errors, repeated sampling, and variability in test results. To minimize these negative effects, alternative blood collection methods can be considered.

The choice between a syringe and a vascular access adapter for blood collection can affect the quality of the samples obtained. Use of a closed system, such as an evacuated tubing system with an intravenous catheter, may result in fewer preanalytical errors compared to an open system like a syringe (30).

In vitro hemolysis, which is defined as the breakdown of red blood cells and the release of hemoglobin into plasma, has a significant impact on laboratory tests. This is an important preanalytical factor and a common source of error affecting a wide range of laboratory tests in clinical laboratories (13). Hemolysis can lead to erroneous test results, requiring test repeats, resulting in additional costs, delays in diagnosis, and also causing patient discomfort (31). The interference caused by hemolysis in laboratory diagnostics is a result of several coexisting biological and analytical causes, including leakage of hemoglobin and other intracellular components from the vascular compartment, method- and analyte-dependent spectrophotometric interferences, and chemical interference in various analytical reactions (32). Hemolysis can cause interference and bias in up to 39 biochemical parameters (24). Hemolysis is a common concern for patient safety as it might lead to inaccurate laboratory results, the need for sample recollection, and potential delays in diagnosis and treatment (20). This is also a major challenge in identifying and rejecting samples in clinical laboratories; It accounts for 40% to 70% of all rejected and inappropriate samples (33). Besides this, the effect of hemolysis on routine biochemical parameters is well known (34). The break down of red blood cells cause the release of intracellular components into the plasma, affecting the accuracy of test results. Biochemical parameters mostly affected by hemolysis include AST, LDH, potassium, and haptoglobin levels (14, 32). Hemolysis can alter the analyte concentration in serum or plasma, leading to erroneous results (16). Moreover, hemolysis may affect the specificity of certain tests, such as the serum neuron-specific enolase (NSE); and lead to falsely high results, affecting clinical decisions (35). Hemolysis can also affect red cell parameters in complete blood cell count because plasma-free hemoglobin from hemolyzed samples can lead to alterations in red cell indices (36). It is crucial to note that hemolysis is a major problem during laboratory testing and is considered to be a significant risk during blood collection and the the most common pre-analytical error in clinical settings (37). Therefore, extra care given during blood collection and processing practices are important to prevent hemolysis and ensure the accuracy of biochemical results.

The results of the present study showed that taking blood with a vascular access adapter significantly decreased the rate of hemolysis compared to taking blood with a syringe ($p<0.001$). We also found that 7 among 12 tests frequently analyzed in emergency departments (total protein, urea, LDL, AST, ALT, potassium, sodium) were negatively affected by hemolysis. Recent studies have shown that using straight needle venipuncture instead of a syringe in emergency departments is effective in reducing hemolysis rates and recommend this as an evidence-based practice (24). Additionally, the use of specific vascular access materials for blood collection has been independently associated with a significant reduction in hemolysis compared to syringes which highlights the potential benefits of specific blood collection devices in reducing hemolysis rates.

CONCLUSION

In conclusion, the use of appropriate vascular access adapters instead of syringes in emergency departments may have significant

effects on laboratory test safety and quality. For choosing the most appropriate blood collection method; healthcare professionals should consider the potential impact on hemolysis rates, patient comfort, and reliability of analytical results.

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