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ORIGINAL ARTICLE

Comparison of Fingertip Hemoglobin Value with Venous Hemoglobin Value in Bleeding Patients Followed at the Emergency Department

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SUMMARY

Background: **Hemoglobin's pivotal role in human health is monitored through hospital-based complete blood count (CBC) by utilizing automated methods like electrical impedance and photon scattering. This study explored bedside fingertip hemogram and hematocrit analysis' reliability versus CBC´s in emergency department patients, crucial for hemorrhagic condition management.**
Methods: **The study included emergency department patients requiring hemogram monitoring. Participant data, CBC, and fingertip hemogram and hematocrit result values from venous blood using a conventional device were compared during monitoring.**
Results: **In this study, 88 participants (63.6% female, mean age 47.68 ± 19.80) were assessed for hemoglobin and hematocrit levels using both fingertip and conventional methods. Fingertip hemogram measurements showed a significant correlation with conventional CBC devices, yet tended to be 1.20 g/dL lower. Similarly, fingertip hematocrit measurements correlated positively but were 3.59% lower compared to conventional measurements.**
Conclusions: **Bedside fingertip devices for hemogram measurement in emergency departments provide time-efficient and resource-saving advantages.**
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INTRODUCTION

Hemoglobin holds a significant position in tracking important and fundamental life values for humans. For this purpose, complete blood count (CBC) is performed in hospitals. These measurements, which are based on methods such as electrical impedance and photon scattering, are conducted using automated devices [1]. With their development, these devices play a crucial role in the identification of main values of complete blood count and in the early diagnosis of certain conditions. They enable the differentiation of specific cells such as reticulocytes and immature granulocytes [2,3]. The preparation of the necessary sample for these devices involves collecting 2 - 3 mL of peripheral venous blood, which is then transported and analyzed in a tube containing EDTA. During this process, it is necessary to access the patient's peripheral veins.

Complete blood count (CBC) emerges as a vital test in the emergency department, especially in cases of trauma and hemorrhage. Various devices and procedures have been developed for this purpose. This measurement process can result in some erroneous results both before and during the analysis. Following the development of automated systems by the Coulter brothers, there has been a reduction in time and errors. Since the 1980s, CBC has allowed for the measurement of 18 parameters from 200 micrograms of blood within an average duration of 1 minute [4]. Flow cytometric methods began to be used to provide identifying information on white blood cells, which was a limitation of this method [5].

In trauma patients monitored in the emergency department, pre-hospital fluid management and, when necessary, blood replacement can prevent mortality and reduce morbid conditions [6]. Hemogram monitoring is critical and sometimes essential at various stages of life, such as in preterm and term newborns, who have different hemogram values and critical conditions [7]. During the monitoring of patients in the emergency department, time intervals are of vital importance. In situations like trauma, the hemogram and hematocrit values, which are part of the patient's monitoring, need to be closely observed [8].

Monitoring hemogram and hematocrit values during bedside monitoring in the emergency department is crucial for hemorrhagic patients. This study aimed to investigate the reliability of fingertip hemogram and hematocrit analysis, which can be applied at the bedside, by comparing it with CBC measurements in emergency department patients under bleeding monitoring.

MATERIALS AND METHODS

In the study, patients admitted to the emergency departments of the included centers who required hemogram monitoring were included. Patients under 18 years of age and those who did not consent to participate in the study were excluded. The demographic data of the participants, complete blood count results, fingertip hemogram results, vital signs, LDH, total bilirubin, and indirect bilirubin values were recorded. During the patient's monitoring, the hemoglobin and hematocrit values measured from a venous blood sample using a conventional device (Sysmex, XN-350, Canada) were compared.

Sample size

In previous studies, analyses were conducted with 29 participants [9]. In another study conducted on the capillary system, 79 participants were examined [10]. In our study, we aimed to include at least 60 participants.

Fingertip hemogram measurement

In the study, samples obtained from the participants' fingertip peripheral blood were used. For this, after cleaning the patient's fingertip, a sample was taken using a lancet. The first drop of blood was wiped away, and the sample obtained afterward was measured using a hemoglobin test device (fasttest Hblyzer, Plusmed). For fingertip hemoglobin measurement, the device performs a quantitative analysis of blood obtained from the capillary system. This involves dropping a 10-microliter sample onto the measurement strip, followed by photometric measurement of the reactive strip. Fresh blood is used during this procedure [11].

Fingertip hemogram measurement is considered a cost-effective method compared to CBC analysis performed with conventional devices, as it can be conducted at the patient's bedside and provides results within 15 seconds. This process prevents wastage of resources that would normally be spent on sample collection and transfer.

Traditional hemogram measurement

Simultaneous venous blood samples collected from the patients were analyzed in the hospital's biochemistry laboratory using tubes containing EDTA for the hemogram. During the patient's monitoring, hemoglobin and hematocrit values measured from the venous blood sample with a conventional device (Sysmex, XN-350, Canada) were determined.

The sample collection from patients was performed simultaneously with the fingertip sample collection, using a vacutainer from the antecubital region after local cleaning. Tubes with negative pressure were used, and 2 mL of blood were collected into the tube, which was then gently rotated by 360 degrees to ensure contact with the EDTA inside. The samples were transported to the laboratory within an average of 15 minutes and analyzed within 30 minutes.

Statistical analysis

The data obtained from the study were entered into a database and analyzed using IBM SPSS version 27. Frequency and percentage values were used to describe categorical data. Distribution analysis of numerical data was performed. Data that followed a normal distribution were described as mean ± SD. For data not following a normal distribution, the median IQR value was described. Bland-Altman analysis was used to compare the hemoglobin and hematocrit values determined by conventional and fingertip measurements, and Pearson correlation analysis was used to analyze the parameters affecting the difference between the two methods. Data with a p-value below 0.05 were considered significant.

Table 1. Demographic, vital, and laboratory findings.

Specification		
Gender (n, %)	Female	65 (63.6)
	Male	32 (36.4)
Age (mean ± SD)		47.68 ± 19.80
SBP (mean ± SD)		128.45 ± 19.99
DBP (mean ± SD)		79.43 ± 11.76
Pulse (mean ± SD)		86.78 ± 14.87
SPO_2 (mean ± SD)		97.62 ± 2.39
Hemoglobin (mean ± SD)		12.69 ± 2.23
Device hemoglobin (mean ± SD)		11.51 ± 2.53
Hematocrit (mean ± SD)		37.73 ± 6.44
Device hematocrit (mean ± SD)		34.19 ± 6.67
MCV (mean ± SD)		83.8 ± 7.98
MCH (mean ± SD)		27.73 ± 3.48
MCHC (mean ± SD)		33.09 ± 1.87
Total bilirubine (mean ± SD)		0.43 ± 0.39
Direct bilirubine (median (IQR))		0.16 (0.18)
LDH (mean ± SD)		196.73 ± 60.83

Table 2. Comparison of hemogram and hematocrit values.

	Hb	Htc
Arithmetic mean	-1.2035 (-1.4697 to -0.9374)	-3.59 (-4.81 to -2.38)
p-value	< 0.001	< 0.001
Lower limit	-3.62 (-4.078 to -3.16)	-14.63 (-16.71 to -12.54)
Upper limit	1.21 (0.758 to 1.67)	7.44 (5.35 to 9.52)

Table 3. Correlation analysis of the difference in hemogram and hematocrit values.

Specification		MCV	MCH	MCHC	T.Bil	I.Bil	LDH
Hb	Pearson´s correlation	0.204	0.230	0.210	0.080	0.080	-0.066
	p-value	0.057	0.031	0.050	0.463	0.464	0.587
Htc	Pearson´s correlation	-0.039	-0.117	-0.164	0.023	0.043	-0.081
	p-value	0.716	0.278	0.127	0.834	0.692	0.501

RESULTS

Eighty-eight participants were included in the study, with 63.6% being female. The average age of the participants was 47.68 ± 19.80 years, their average hemoglobin levels were observed to be 12.69 ± 2.23 g/dL, and their average hematocrit levels were found to be 37.73 ± 6.44%. The demographic findings, vital signs, and laboratory findings of the participants are presented in Table 1.

A statistically and clinically significant difference was observed between the fingertip hemogram measurement

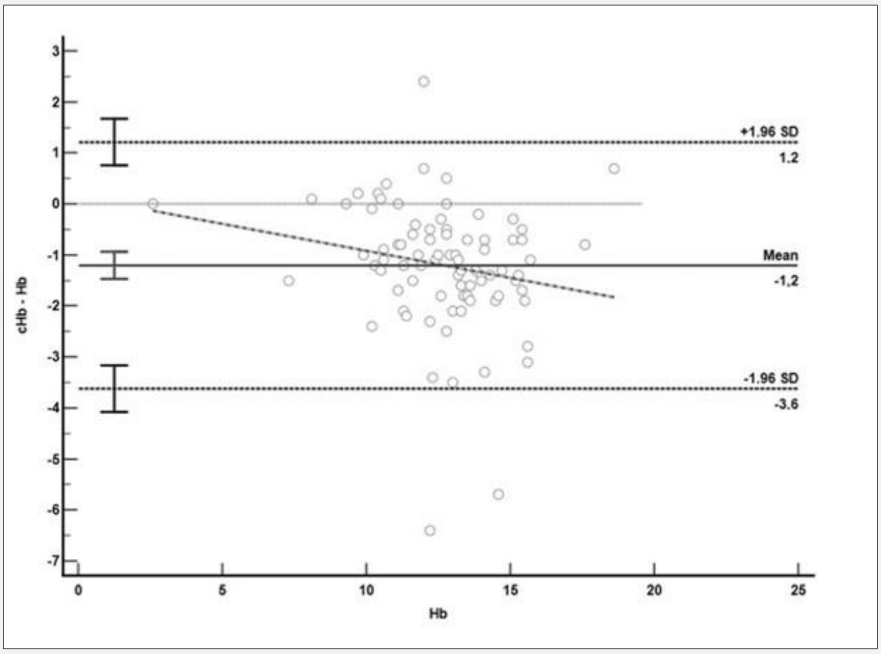

Figure 1. Analysis of hemogram value difference.

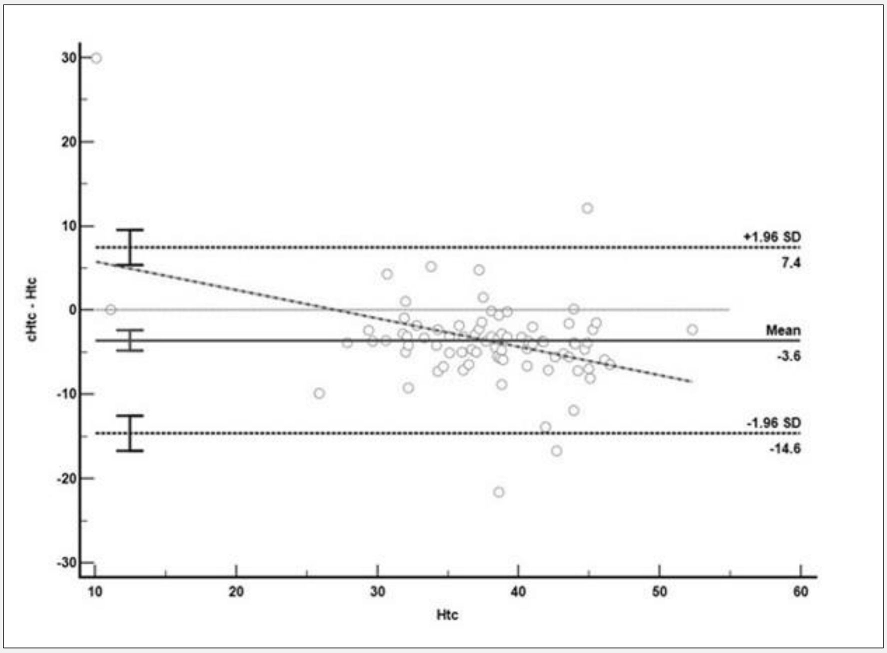

Figure 2. Analysis of hematocrit value difference.

and the conventional method. In the correlation analysis conducted for the hemoglobin parameter, a significant correlation was found between the fingertip measurement and the conventional CBC device (Pearson´s correlation = 0.855, p-value < 0.001). The fingertip hemogram measurement tended to be lower compared to the conventional device; it was observed that the fingertip hemoglobin measurement was 1.20 g/dL lower compared to the conventional device. In the correlation analysis conducted for the hematocrit parameter, a positive correlation was found between the fingertip measurement and the conventional CBC device (Pearson´s correlation = 0.642, p-value < 0.001). There was a significant difference between the fingertip hematocrit value and the conventional measurement, with the fingertip hematocrit device measuring 3.59% lower compared to the conventional system. Hemogram and hematocrit comparisons are presented in Table 2.

In the correlation analysis conducted between the difference in hemoglobin results obtained by the conventional method and the fingertip method, it was found that MCH and MCHC values produced a positive correlation. It was determined that with the increase in MCH and MCHC values, the difference observed between the fingertip hemogram measurement and the conventional method measurement increased significantly, while no significant difference was observed in the determination of the hematocrit value (Table 3).

DISCUSSION

In our study involving 88 participants monitored for hemorrhagic conditions in the emergency department, the bedside hemoglobin and hematocrit values of patients were analyzed using a fingertip hemogram analysis device. Compared to conventional methods, the device provided results that were 1.20 g/dL lower for hemoglobin and 3.59% lower for hematocrit, with an average result time of 15 minutes. While a significant correlation was observed between the conventional device and the fingertip measurement, the fingertip hemogram and hematocrit measurements tended to be slightly lower.

Bedside hemogram follow-up in the emergency room (ER) is a critical component of patient management, offering rapid and reliable diagnostic information that can significantly influence clinical decision-making. Studies have demonstrated that point-of-care (POC) testing, such as capillary blood sampling for full blood count (FBC), provides a convenient and minimally invasive alternative to traditional venous sampling, with clinically acceptable accuracy for most parameters, including total white cell count and hemoglobin, although slight deviations in platelet counts and hemoglobin levels were noted [12]. The use of POC devices for hemoglobin measurement has shown good agreement with central laboratory results, significantly reducing turnaround time by approximately 207 minutes, which can enhance patient throughput and decrease length of stay in the ER [13]. Furthermore, bedside testing is particularly valuable in emergency settings where rapid results are essential for immediate therapeutic decisions, such as in cases of trauma-associated coagulopathy, where monitoring hemostasis is crucial for guiding treatment and predicting transfusion needs [14,15]. The integration of hematological parameters into clinical guidelines, as seen in the management of COVID-19 patients, underscores the potential of these tools to improve patient outcomes by providing timely and actionable data [13]. Overall, bedside hemogram follow-up in the ER is a vital practice that supports efficient and effective patient care through rapid diagnostics and informed clinical decision-making.

Various differences were observed between venous samples and fingertip samples. In a study by Yang et al., it was noted that venous blood results are better compared to fingertip or arterial blood [16]. Hemoglobin and hematocrit measurements are also performed in commonly-used blood gas analyzers today. In a study by Rejan et al., higher results were observed in blood gas analyzer measurements compared to conventional measurements in preoperative samples [17]. In a retrospective study by Zhao et al., it was indicated that hemoglobin and hematocrit results were lower in blood gas analysis compared to the conventional method [18]. In our study, we found that fingertip hemoglobin and hematocrit values tend to be lower compared to the conventional device.

Another important aspect in hemoglobin and hematocrit measurements is the sample type. Conventional systems produce different results with different samples. In a study by Kayiran et al., CBC results obtained from the capillary system and the venous system were compared, emphasizing that although hemoglobin and hematocrit values may be lower, consistent results can be obtained [19]. A study by Bates-Fraster et al. also indicated similar results, stating that it can be used consistently [20]. As seen in studies in the literature, while the sample collection method and analysis method create various differences, the consistent results obtained allow for the use of reliable tests. The fingertip hemogram device used in our study analyzes blood obtained from the capillary system. As observed in literature examples, lower hemoglobin and hematocrit levels in samples obtained from capillary blood are a natural result, and our study is consistent with this. The monitoring of blood values is particularly important in patients followed for major trauma. Minimizing the time spent in this management process is recommended [21]. A study by Torres et al. demonstrated a significant correlation between blood transfusion time and emergency department discharge and survival [22]. The equipment used in our study performed bedside measurements in a short time period of 15 seconds, which is seen as a significant advantage, especially in bleeding monitoring. This is particularly salient in the context of the alterations that are to be identified during patient monitoring, as it has the potential to engender substantial advances in the determination of bleeding and blood transfusion in the emergency department, which, in turn, can lead to enhanced survival outcomes.

Limitations
There are some limitations in our study. The primary limitation is that patient monitoring was conducted in the emergency department. While examining other parameters and selecting similar samples could demonstrate the reliability of the device for measurement consistency, we conducted our comparison within the normal process of the emergency department. Additionally, extending the study with a larger sample size could allow for a more consistent determination of the deviation.

CONCLUSION

Fingertip devices that can be used bedside for hemogram measurement, which is one of the procedures that needs to be quickly performed in the emergency department, offer advantages in both time and resource management. They can be utilized for monitoring and tracking patients' hemogram and hematocrit levels.

Ethical Approval Statement:
Ethics committee permission for this study was received from SBU Antalya Training and Research Hospital Non-Interventional Scientific Research Ethics Committee. The second center participating in the study is MoH Hatay Defne State Hospital.

Data Availability Statement:
Data from the study can be shared upon individual request in accordance with the rules of the Declaration of Helsinki.

Declaration of Interest:
The authors declare that they have no conflicts of interest.

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