The Comparison of Routine Hematology Test Between Veins and Capillary Blood: Studies on Hematology Analyzer

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Abstract—Routine hematological parameters is a basic assessment of blood component, which determines the amount, variation, percentage, concentration, and quality of blood. The type of sample used was venous blood with EDTA anticoagulants. Currently there is a hematology analyzer which analyses capillary blood for routine hematological parameters. This research aims to determine the feasibility of capillary blood samples as an alternative sample on routine hematological parameters using Medonic M-series M32. The method used in this research was comparative analytic cross sectional. Venous and capillary blood from 70 healthy students of D-IV MLT Health Polytechnic of Jakarta III was used in this research. The researchers took 3 mL of venous blood and 20 µL of capillary blood. Then, the researchers performed the routine hematological parameters on the hematology analyzer. The results were calculated using independent t test (normal data distribution) or Mann-Whitney test (abnormal data distribution). The hypothesis used was 90% of interval confidence (α = 0.1). The results of significant difference test shows the probability value (p) on parameters Hb, Ht, leukocyte and erythrocytes count were more than α (0.1). Thus, there is no significant difference between venous and capillary blood for the parameters. The p value for platelet count is less than α (0.1), and as the results, it shows that there is significant difference between venous and capillary blood samples. The conclusions of this research are capillary blood can be used as an alternative sample for the parameters hemoglobin, hematocrit, leukocyte and erythrocytes count using hematology analyzer Medonic M-series M32. On the contrary, capillary blood is not recommended for platelet count.

Keyword: hematology analyzer, capillary blood, venous blood

1. INTRODUCTION

A routine hematology examination is a basic assessment of determining the amount, variation, percentage, concentration, and quality of blood component. This examination is conducted to determine the history of a person's illness and help the doctor in diagnosing a disease (Estridge, 2012). The routine hematologic examinations that are often done are hemoglobin examination and blood cell count. Blood cells consist of erythrocytes, leukocytes and platelets. The method recommended by the International Council for Standardization in Hematology (ICSH) in determining the results of routine hematology examinations is automation (Estridge, 2012). The excellence of the automation method using hematology analyzer is its precision and accuracy compared to the manual method. The current automation method is more reliable than the manual because of using control material, fast checking time, and results printing are done automatically (Estridge, 2012).

Currently, hematology analyzer technology used for blood cell counts is the electrical impedance technique. The basic principle is measurement based on changes in electric current. Cells are electrical insulators which inhibit electrical conduct. Two electrodes in an electrolyte liquid are connected with a narrow gap. Cells will be moved through the

gap, one by one causing pulsation of electrical resistance. The size of the cell through the gap is proportional to the magnitude of the stress that arises (Bain, 2006).

The type of sample used for this routine hematological examination is venous blood. Currently, there is a hematology analyzer that can use capillary blood for routine hematological parameters, such as the Medonic M-series M32 devices. Capillary blood can be used for limited test because of the small number of sample volumes, with a maximum blood volume of 500 µL. Based on the literature, not all routine hematological parameters can be analyzed using capillary blood, such as platelet counts and leukocytes. This is because there are significant differences in results(Lewis S.M., Bain BJ., Bates I., 2017; McCall, RE & Tankersley, 2016). This research will used routine hematological parameters which included analysis of hemoglobin levels, hematocrit values, and calculation of blood cells number in the Medonic M-series M32 device. The aim of the research is to determine the feasibility of capillary blood samples as an alternative sample in routine hematological parameters using the Medonic M-series M32 hematology analyzer not come from the Indonesian language it must be in italics.

2. MATERIALS AND METHOD

The materials used in this research were Hematology analyzer Medonic M-series M32 devices, reagent of medonic, control of medonic (low, normal and high levels), capillary tube of medonic, needle, and EDTA tube.

This research was conducted on August 2017 to June 2018 in the hematology laboratory of the Medical Laboratory Technology Department (TLM) Health Polytechnic Jakarta III Ministry of Health. The population in this research was the students of Diploma IV of Medical Laboratory Technology Health Polytechnic Jakarta III Ministry of Health. This research used 70 samples with healthy physical characteristics. Before checking blood sample, the accuracy of medonic was checked using three levels of medonic controls. If control results were on range, blood sample were taken. Each respondent took blood from their veins and capillaries, and then they were checked with medonic M-series M32. The capillary blood was checked using capillary tube of medonic M-seris M32.

The comparison of routine hematological results between venous and capillary blood was analyzed by statistical tests. The use of independent t-test is done if the data is normally distributed using Kolmogorov Smirnov. If the data is not normally distributed then the alternative is the Mann-Whitney test. The T test is done by comparing the results of significant statistical calculations referring to the hypothesis that has been determined with a confidence level of 90% ($\alpha = 0.1$).

3. RESULTS AND DISCUSSION

The routine hematology examination was conducted on 70 venous and capillary blood samples from D-IV TLM students of the Ministry of Health Poltekkes Jakarta III. The samples were analyzed using the Medonic M-series M32 hematology analyzer which was equipped for the analysis of venous and capillary blood samples.

Table 1. Distribution of Routine Hematology Results (Calculate Hb, Ht, Leukocytes, Erythrocytes, Platelets) between Venous and Capillary Blood

Routine Hematology Parameter	Venous Blood			Capillary Blood		
	Min	Maks	average	Min	Maks	average
Hemoglobin concentration (g/dL)	8,2	15,0	12,5	8,7	15,0	12,4
Hematocrit (%)	25,7	43,5	36,1	27,3	44,5	36,9
Leukocytes (sel/µL)	3.700	16.700	7.494	3.800	15.200	7.806
Erytrocytes (x 10^6 sel/µL)	3,93	5,80	4,70	3,93	6,03	4,73
Platelets (sel/µL)	173.00	504.00	310.00	99.00	334.00	185.99

The table above is the distribution of routine hematological results data (hemoglobin concentrations, hematocrit, leukocytes, erythrocytes and platelets counts) between venous and capillary blood. The results of venous blood hemoglobin concentrations obtained a minimum value of 8.2 g / dL, a maximum value of 15.0 g / dL and an average value of 12.5 g / dL. The distribution of hemoglobin concentrations in capillary blood is a minimum value of 8.7 g / dL, a maximum value of 15.0 g / dL and an average value of 12.4 g / dL. The results of venous blood hematocrit count were a minimum value of 25.7% and a maximum value of 43.5% with an average of 36.1%. The hematocrit data distribution in capillary blood obtained a minimum value of 27.3% and a maximum value of 44.5% with an average of 36.9%. The data distribution of leukocyte count results on venous blood were a minimum value of 3,700 cells / µL and a maximum value of 16,700 cells / µL with an average of 7,494 cells / µL. The distribution of leukocyte count data in capillary blood were a minimum value of 3,800 cells / µL and a maximum value of 15,200 cells / µL with an average of 7806 cells / µL. The results of venous blood erythrocyte count were a minimum value of 3.93 x 106 cells / µL, a maximum value of 5.80 x 106 cells / µL and an average of 4.70 x 106 cells / µL. The data distribution of erythrocyte count in capillary blood were a minimum value of 3.93 x 106 cells / µL, a maximum value of 6.03 x 106 cells / µL and an average of 4.73 x 106 cells / µL. The results of the venous blood platelet count were a minimum value of 173,000 cells / µL, a maximum value of 504,000 cells / µL and an average of 310,000 cells / µL. The distribution of platelet count data in capillary blood were a minimum value of 99,000 cells / µL, a maximum value of 334,000 cells / µL and an average of 185,990 cells / µL (Table 1.) To state whether there were significant differences in each routine hematological parameter between venous and capillary blood, statistical tests of significant differences were performed. Before the test was conducted, the normality of data test was conducted with

Kolmogorov-Smirnov test. If the data is normally distributed, an independent parametric t test is used, but if the data is not normally distributed, the non-parametric Mann-Whitney test is used.

Table 2. Test for Normal Distribution of Each Routine Hematological Parameter in Venous Blood and Capillary Blood

Parameter	*Kolmogorov-Smirnov*		
	Sample	Sig	Distribution α (0.1)
Hemoglobin Concentration	Venous Blood	0,066	Abnormal
	Capillary Blood	0,200	Normal
Hematocrit	Venous Blood	0,200	Normal
	Capillary Blood	0,200	Normal
Leukocytes	Venous Blood	0,029	Abnormal
	Capillary Blood	0,085	Abnormal
Erytrocytes	Venous Blood	0,200	Normal
	Capillary Blood	0,200	Normal
Platelets	Venous Blood	0,200	Normal
	Capillary Blood	0,006	Abnormal

On the table 2, it can be seen that the p value (sig column) is compared with the α value, which is 0.1. If the sig value is greater than 0.1, the data is normally distributed. Thus, the data can be analyzed by an independent t test. If the sig value is smaller than 0.1, the data is not normally distributed.

Thus, the data can be analyzed using the Mann-Whitney test. The data distribution for all parameters are varies. The data that have normal distribution are hematocrit and erythrocyte count, so that an independent t test is performed with the results shown in Table 3. Meanwhile, the data that have abnormal distribution are hemoglobin, leukocyte count, platelet count, so the Mann-Whitney test is performed with the results shown in Table 4. The probability value (column sig) compared with α value is 0.1 at a 90% confidence level. If the sig value is greater than 0.1, then it can be concluded that H0 fails to be rejected / accepted. It means that there is no significant difference in the results of routine hematology examinations between venous and capillary blood using a hematology analyzer. If the sig value is smaller than 0.1, it can be concluded that H0 is rejected. It means that there is a significant difference in the results of routine hematological examination between venous and capillary blood using a hematology analyzer.

Table 3. T Test Results of Hematocrit and Erythrocyte Parameters

Parameter	Sample	Avarenge	Sig
Hematocrite	Venous Blood	12,5	0,178
	Capillary Blood	12,4	
Erytrocytes	Venous Blood	36,1	0,592
	Capillary Blood	36,9	

The Hematocrit parameters probability value is 0.178 and erythrocyte parameter has a probability value of 0.592, so it can be concluded that H0 fails to be rejected / accepted. It means that there are no differences in hematocrit results and significant erythrocyte count between venous and capillary blood using a hematology analyzer (Table 3). The examination results with abnormal data distribution, Mann-Whitney test, can be seen in Table 4. In the test, the probability value (sig column) is compared with α value, which is 0.1 at a 90% confidence level. If the sig value is greater than 0.1, it can be concluded that H0 fails to be rejected / accepted. Thus, it means that there is no significant difference in the results of routine hematology examinations between venous and capillary blood using a hematology analyzer. If the sig value is smaller than 0.1, it can be concluded that H0 is rejected and it means that there is a significant difference in the results of routine hematological examination between venous and capillary blood using a hematology analyzer.

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The probability values (sig columns) that have more than 0.1 are 0.861 (hemoglobin) and 0.325 (leukocytes count). This indicates that H0 fails to be rejected and it means that there is no significant difference in hemoglobin examination results

and leukocyte count between venous and capillary blood using a hematology analyzer. In platelet parameters, the probability value is 0,000. It shows that H0 is rejected. In other words, there is a significant difference in the results of platelet count between venous and capillary blood using a hematology analyzer.

Table 4. Comparative Test of Hemoglobin, Leukocyte and Platelet Parameters Results

Parameter	Sample	Avarenge	Sig
Hemoglobin	Venous Blood	12,5	0,861
	Capillary Blood	12,4	
Leukocytes	Venous Blood	7.490	0,325
	Capillary Blood	7.806	
Platelets	Venous Blood	310.000	0,000
	Capillary Blood	185.990	

The use of a hematology analyzer for routine hematological parameters serves to reduce workload. Besides, the use of capillary blood as a sample for routine hematology also provides convenience in sampling, especially in patients who are infants or children The comparative tests between the two types of Medonic M-series M32 sample equipments in this research provides information regarding the performance of the device. The sample used in this research came from individuals with healthy physical characteristics taken from venous and capillary blood. The benchmark was used to see the differences in routine hematological results in capillary blood compared with standard samples, namely venous blood. In the distribution of data (Table 1), it can be seen that from five routine hematological parameters, four of which are hemoglobin value, hematocrit, erythrocyte count, and leukocytes, they have interpretation values in the same range. For example, both of the results of leukocyte counts in venous and capillary blood have a minimum value below the normal value, which is 4,000 cells / µL and a maximum value of both, which is above the normal value (more than 10,000 cells / µL).

However, platelet count results have different interpretations of results between venous and capillary blood.

In the Table 1, it can be seen that the minimum platelet count in venous blood falls into the normal criteria, whereas in capillary blood, it falls into the criteria below the normal value, as well as its maximum value. This illustrates the variation in platelet count results are greater than the other four parameters. The statistical tests in the table 3 and table 4 shows that there are no significant differences in hemoglobin parameters, hematocrit values, counts of leukocytes, and erythrocytes between venous and capillary blood.

It proves that capillary blood can be used as an alternative sample for all four parameters on Medonic M-series M32 devices. The venous blood samples with EDTA anticoagulants are the best sample types for routine hematological parameters. However, the use of capillary blood is still an option in certain conditions, such as infants and individuals with difficult venous access. In addition, if there are not too many examination parameters to be examined, then capillary blood is taken as a sample (McCall, RE & Tankersley, 2016). The statistical test of platelet count between venous and capillary blood shows significant

differences (Table 4). It proves that capillary blood is not recommended for platelet counts on Medonic M-series M32 devices. The capillary blood in contrast to the venous blood is a mixture of arterial and venous blood because it comes from capillary vessels. In addition, during the collection of capillary blood by fingerstick or from the earlobe, some of tissue fluids may seep to the test tube from puncture-damaged tissues (Tomasz Podgorski, Ursula Bartkowiak, 2014). This is supported by the literature which states that taking capillary blood will cause some platelets to tend to adhere and aggregate in endothelial tissue from injured blood vessels, so that only small portion of platelets are collected in the sample container and it can cause false low results. The difference in platelet count between venous and capillary blood ranges from 9% to 32%. The present study shows a lower platelet count in the capillary blood in comparison with the venous blood (Tomasz Podgorski, Ursula Bartkowiak, 2014). In addition, low platelet counts may make work mistakes, such as: dilution of capillary blood samples caused by insufficient puncture so that the blood coming out is not smooth and usually the fingers will be pressed or sorted and cause platelet count results tend to be low (Bain, 2015)(Lewis S.M., Bain BJ., Bates I., 2017). Other sample preparation error factors that can cause routine hematological errors are hemolysis, hemoconcentration or clots.

This error factor can be prevented by means of stabbing must be done well, carefully, and quickly to prevent clots and the skin to be pierced is certainly dry from alcohol (Dunning III, MB & Fischbach, 2009) (Estridge, 2012).

CONCLUSION

There are no significant differences in the results of examination of hemoglobin levels, hematocrit values, erythrocytes and leukocytes count between venous and capillary blood using the hematology analyzer Medonic M-series M32. There are significant differences in platelet count results between venous and capillary blood using the Medology M-32 series.

Using hematology analyzer on capillary blood can be used as an alternative sample on hemoglobin parameters, hematocrit, count of leukocytes and erythrocytes using the hematology analyzer Medonic M-32 series, while capillary blood is not recommended for platelet counts.

ACKNOWLEDGEMENT

We thank MRK Diagnostics for supporting and allowing us to work on Medonic M Series M32. Thanks to Ruben Schnapke, the general manager of MRK Diagnostics and Suprayogi as application supervisor for supporting materials used in this research. This research was conducted with ethical clearance from the Ethical Committee of the Health Polytechnic Jakarta III Ministry of Health.

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