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Comparison of Hematocrit Results Based on 1-Minute and 4-Minute Tourniquet Duration

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Abstract: This study aims to compare the results of hematocrit levels based on blood retention time for 1 minute and 4 minutes. The design of this study was an experimental laboratory with the subjects of the study being 3rd year D-III Medical Laboratory Technology students of STIKES Panrita Husada Bulukumba. A total of 17 samples were selected using a purposive sampling technique. The dependent variable of the study was hematocrit levels, while the independent variable was the duration of retention. Data analysis was performed using the Wilcoxon test through SPSS 20. The results showed that the average hematocrit level at 1 minute retention was 0.37%, while at 4 minutes retention it increased to 0.40%. Statistical analysis showed a significant difference between the two retention times with a p value = 0.000 ($p < 0.05$). The increase in hematocrit levels at 4 minutes retention was caused by hemoconcentration due to the longer retention duration. The implication of this study is the need for consistency in retention time during blood sampling to prevent biased examination results.

INTRODUCTION

Hematocrit is a test that measures the proportion of red blood cell volume relative to the total blood volume, typically expressed as a percentage. Hematocrit tests are commonly used to evaluate a patient's health conditions, such as anemia, dehydration, or other diseases that affect blood composition. To determine whether an individual's hematocrit level is within the normal range, a complete blood count (CBC) is performed. The hematocrit value provides critical information; for example, a hematocrit level of 46% indicates that 46 milliliters of blood out of 100 milliliters consist of red blood cells.

The standard procedure for a hematocrit examination involves drawing venous blood using a tourniquet. The tourniquet serves to enlarge and highlight the vein, facilitating needle insertion. However, prolonged occlusion of the blood vessel can lead to hemoconcentration—an increase in red blood cell concentration due to plasma leakage into the surrounding tissue. This condition affects hematocrit readings and other laboratory parameters. Previous studies have shown that occlusion for more than one minute can elevate hematocrit levels, potentially introducing bias into diagnostic or clinical evaluations (Hsu et al., 2019).

One major challenge is that the duration of tourniquet application is often overlooked by laboratory personnel, which can result in inaccurate hematocrit test results. Research

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by Lippi and Hsu et al. (2019) demonstrated that applying a tourniquet for more than one minute can increase hematocrit levels by 3.7% to 7.3%, depending on the duration of occlusion. This variation is significant and may impact clinical decisions, particularly in cases such as dengue hemorrhagic fever (DHF), where hematocrit is a key diagnostic and monitoring parameter.

A critical factor in this issue is the mechanism of hemoconcentration caused by prolonged tourniquet application. Hemoconcentration occurs when blood plasma exits the blood vessels and moves into surrounding tissues, leaving cellular components, including erythrocytes, within the vessels. This shift increases the ratio of erythrocytes to total blood volume. Consequently, prolonged occlusion not only affects hematocrit levels but also influences other blood test parameters, such as hemoglobin and total red blood cell count. Thus, proper control of tourniquet duration is crucial to ensure the validity of hematology test results.

Inaccurate test results can have serious implications for clinical decisions. For instance, in DHF cases, an increase in hematocrit is used as an indicator of hemoconcentration caused by plasma leakage. Misinterpreting hematocrit levels could delay or result in errors in fluid therapy, potentially worsening the patient's condition. Therefore, understanding how variations in occlusion duration impact hematocrit results is essential to avoid adverse clinical outcomes. Furthermore, controlling variables such as occlusion duration is vital in laboratory studies to ensure reproducible and valid results.

This study builds on prior research highlighting the effect of tourniquet application on hematology results. Chairani et al. (2022) found that applying a tourniquet for more than one minute significantly increases hematocrit values. Similarly, Syuhada (2022) emphasized that while hemoconcentration-related hematocrit increases can serve as useful indicators, inconsistent tourniquet application times may compromise result interpretation. In this context, the present study aims to provide additional insights into hematocrit variations between one-minute and four-minute occlusion durations, offering clearer guidance for laboratory practices.

By conducting an in-depth analysis of the effects of tourniquet application duration, this study seeks to offer practical recommendations for clinical laboratories in standardizing occlusion times. Establishing such standards is essential for improving the consistency and validity of laboratory results, thereby supporting more accurate medical decision-making. Additionally, this study aims to serve as a foundation for future research investigating other variables, such as occlusion pressure or patient body position, and their influence on hematological parameters.

METHOD

This study employed a descriptive numerical laboratory experimental design to compare hematocrit results based on the duration of tourniquet application. The research was conducted at the Caile Health Center Laboratory in Bulukumba, with participants drawn from the third-year students of the DIII Medical Laboratory Technology program at Panrita Husada Health College, Bulukumba.

The study population included all third-year students of the DIII Medical Laboratory Technology program, with a sample of 17 participants selected using a simple random sampling technique. Subjects were chosen randomly based on inclusion criteria, which required them to meet health standards necessary for blood sampling. This sampling method aimed to minimize bias, ensuring that the results more accurately represent the population.

The tools used in this study included a tourniquet (tensiometer), microcapillary tubes (microhematocrit), clay or a micro burner, a hematocrit scale (microhematocrit), and a small centrifuge (microhematocrit). The materials comprised venous blood, syringes or vacuum needles, 70% alcohol swabs, gloves, adhesive bandages, and tissues. All tools and materials were sterilized and met standard requirements to ensure the validity of the results.

Blood sampling was performed through venipuncture on the median cubital vein, with a 1-minute tourniquet application on the right arm and a 4-minute application on the left arm, using a pressure of 50 mmHg. Blood drawn from each arm was collected into microcapillary tubes, filling them to 2/3 to 3/4 of their capacity. The tubes were sealed with clay and placed in a centrifuge in opposite positions to maintain balance. The samples were centrifuged for 5 minutes at a speed of 11,000–16,000 rpm, and hematocrit values were measured using a graph or hematocrit reading device.

The data were analyzed using SPSS Statistics 20 software. The Wilcoxon statistical test was employed to evaluate the difference in hematocrit results between the 1-minute and 4-minute tourniquet application durations. A p-value of less than 0.05 was considered statistically significant.

RESULT AND DISCUSSION

This research was conducted at the Caile Health Center Laboratory, Ujung Bulu District, Bulukumba Regency, which was conducted on April 18, 2024, and can be shown in the primary data table of the examination results as follows:

Table 1. Hematocrit Examination Results Based on Holding Time of 1 Minute and 4 Minutes

No	Sample Code	Age	Gender	1 Minute Containment Results (%)	4 Minute Containment Results (%)
1	PA	21	P	37	39
2	IA	21	P	37	38
3	AR	21	L	41	43
4	WS	22	L	42	45
5	RI	21	P	37	39
6	S	20	P	37	39
7	AM	21	L	40	42
8	P	21	P	38	40
9	NS	21	P	37	40
10	NF	22	P	39	41
11	FZ	21	P	38	40
12	HA	21	P	37	39
13	WE	21	P	38	39
14	MA	21	P	37	40

15	A	22	P	37	39
16	WA	21	P	38	40
17	AU	21	P	37	39

Table 1 shows the results of hematocrit examination of 17 samples based on holding times of 1 minute and 4 minutes. Data includes information on sample code, age, gender, and hematocrit values from both durations of containment. In general, the results of 4 minute damming were higher than 1 minute damming, which shows the influence of damming duration on hematocrit values. For example, the sample coded WS shows an increase from 42% (1 minute) to 45% (4 minutes), while the other samples show a similar pattern with varying increases.

Table 2. Gender data description

Gender	Frequency	Percent
Man	3	17,6
Woman	14	82,4
Total	17	100,0

Table 2 presents the gender distribution of the research subjects. Of the total 17 samples, the majority were female, 14 people (82.4%), while only 3 men (17.6%). This proportion reflects the research population dominated by women, namely 3rd year students of the DIII Medical Laboratory Technology study program at STIKES Panrita Husada Bulukumba.

Table 3. Description of Research Results Comparing Results Based on Damming Time of 1 Minute and Damming of 4 Minutes.

Damming Results	N	Median (Min-Max)
1 Minute Damming	17	0,37 (0,37 – 0,42)
4 Minute Damming	17	0,40 (0,38 – 0,45)

Table 3 depicts a statistical description of hematocrit values based on duration of containment. At 1 minute containment, the median hematocrit value was 0.37 with a minimum range of 0.37 and a maximum of 0.42. Meanwhile, at 4 minutes of containment, the median hematocrit value increased to 0.40 with a minimum range of 0.38 and a maximum of 0.45. This data shows that holding for 4 minutes produces a higher hematocrit value than holding for 1 minute.

From the results of table 2 data processing through statistical descriptions shows that the value of the 4-minute damming results is higher than the 1-minute damming results. The median value of the 1-minute damming results is 0.37 with a minimum value of 0.37 and a maximum value of 0.42. The average value of the 4-minute damming results is a median of 0.40 with a minimum value of 0.38 and a maximum value of 0.45.

From the 34 samples obtained, a normality test was first performed. This is very important to know whether the data obtained is normally distributed or not in order to know the next test steps. The normality of data is tested using the Shapiro-Wilk test because the data is <50. If the p value> 0.05 then the assumption of data normality is met or accepted,

conversely if the p value <0.05 then the normality of the data is rejected. In this study, a data normality test was first performed using the Shapiro-Wilk test, because the sample was small, namely less than or equal to 50, so the following results were obtained.

Table 4. Results of the Normality Test for Data Distribution in the Examination of the Results of 1 Minute Damming and 4 Minute Damming

Damming Results	Shapiro-Wilk		
	Statistic	Df	Sig
1 Minute Damming	0,728	17	0,000
4 Minute Damming	0,802	17	0,002

Table 4 shows the results of the normality test using the Shapiro-Wilk method. The 1-minute damming result has a probability value (Sig) of 0.000, while the 4-minute damming result has a probability value of 0.002. Both of these Sig values are less than 0.05, which indicates that the data is not normally distributed. Therefore, further statistical analysis uses a non-parametric test, namely the Wilcoxon test.

Wilcoxon test data analysis displays test results that show conclusions about whether the average results of the comparative analysis of hematocrit results based on the duration of the dam have a significant difference in the average or significant average.

Table 5. Wilcoxon Test Results

Damming results	N	Median (Min-Max)	A	P Value
1 Minute Damming Results	0	0,37 (0,37 – 0,42)	0,03	0,000
4 Minute Damming Results	0	0,40 (0,38 – 0,45)		

Table 5 presents the results of statistical analysis using the Wilcoxon test to compare hematocrit values based on the duration of the dam. The median hematocrit for 1 minute dam was 0.37 (range 0.37–0.42), while for 4 minutes dam was 0.40 (range 0.38–0.45). A p-value of 0.000 indicates a significant difference between the two dam times ($p < 0.05$). The parameter "A" of 0.03 indicates the average level of change identified in the test. These results indicate that the duration of dam has a significant effect on hematocrit results.

The results of this study indicate that the duration of damming has a significant effect on hematocrit values. Based on Table 1, all samples showed an increase in hematocrit values when damming was carried out for 4 minutes compared to 1 minute. The average hematocrit value for damming for 1 minute was 0.37, while for 4 minutes it increased to 0.40 (Table 3). This increase can be explained by the phenomenon of hemoconcentration, where longer damming causes plasma fluid to leak out of the blood vessels into the surrounding tissue, thereby increasing the concentration of red blood cells relative to the total blood volume. These results are consistent with previous studies by Lippi G and Hsu et al. (2019), which also found that damming for more than 1 minute significantly increased hematocrit values.

The distribution of the sex of the study subjects (Table 2) shows that the majority of the samples were female (82.4%), with only 17.6% of the samples being male. This difference may reflect the student population in the study program studied, where females

are more dominant. Although this study did not focus on the effect of sex on hematocrit values, this proportion needs to be considered for the interpretation of the results. Several previous studies have stated that hematocrit values can be influenced by biological factors, including sex, with males tending to have higher hematocrit values than females. However, this influence was not directly analyzed in this study, so the duration of the dam remains the main variable affecting the results.

The results of the normality test using the Shapiro-Wilk method (Table 4) showed that the data for both dam durations were not normally distributed ($p < 0.05$). Therefore, the Wilcoxon test was used as a non-parametric statistical method to compare the median hematocrit values between 1-minute and 4-minute dams. The Wilcoxon test results (Table 5) showed a p value of 0.000, indicating a significant difference between the two dam durations. This finding provides evidence that longer dams cause a significant increase in hematocrit values, which should be taken into account in laboratory practice to avoid biased results.

This study has several advantages over previous studies. In addition to confirming the effect of the duration of the dam on hematocrit values, this study used standardized and controlled methods, such as the use of a consistent dam pressure of 50 mmHg and measurement of hematocrit values using the microhematocrit method, which has proven its accuracy. This study also involved a homogeneous subject population, namely third-year students, which minimizes physiological variations that can affect the results. However, this study has limitations, especially in the relatively small sample size and the lack of analysis of additional factors, such as gender or other physiological conditions.

The implication of the results of this study is the need for consistency in the duration of the venous blood draw to ensure the validity of laboratory test results. A draw time exceeding 1 minute, although often occurs in practice, should be avoided because it can cause hemoconcentration and produce a higher hematocrit value than the actual value. For further studies, it is recommended to explore the influence of other variables, such as draw pressure, ambient temperature, or patient body position, on hematocrit results. Thus, this study provides a strong basis for improving standard blood sampling procedures and increasing the accuracy of laboratory test results.

CONCLUSION

This study shows that the duration of the dam has a significant effect on the results of hematocrit examination. The results of statistical analysis using the Wilcoxon test showed a significant difference between hematocrit values at 1 minute and 4 minutes of damming, with a p value = 0.000. The median hematocrit value increased from 0.37 at 1 minute damming to 0.40 at 4 minutes damming, indicating hemoconcentration due to longer damming duration. This finding is in line with previous studies that emphasize the importance of standard damming duration to prevent bias in laboratory test results, especially in hematological parameters such as hematocrit. This study adds evidence that damming for more than 1 minute can significantly affect laboratory results, which can have an impact on clinical diagnosis and medical decision making. This study contributes to the development of standard procedures in the laboratory, especially in blood sampling. To

maintain the validity of the results, the duration of damming must be strictly controlled, especially in cases of critical illnesses such as dengue hemorrhagic fever (DHF), where the hematocrit value is an important indicator of plasma leakage. Further studies are recommended to explore the influence of dam pressure, patient physiological factors, or other variables such as dehydration conditions, to broaden the understanding of factors that may affect hematocrit and other hematological parameters. The results of this study are expected to be a guide for laboratories to improve the accuracy and consistency of examination results.

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