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Correlation between pulmonary embolism and blood cell count changes

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ABSTRACT

Pulmonary embolism is one of the acute diseases of the respiratory system. This study investigates changes in red blood cell counts in pulmonary embolisms confirmed by scintigraphy. Counting red blood cells is essential in diseases, especially pulmonary embolism, because of the vital role of these cells. In this study, 25 patients with pulmonary embolism were selected. A group of 25 healthy volunteers was also considered as a control. At zero, 30, 60 minutes, 24, 48, and 72 hours, blood samples were taken from both control and patient groups, and red blood cells were counted according to the standard method. After extracting technetium-99m from the molybdenum generator, this substance was added to the MAA drug kit under particular conditions. After preparation, radiopharmaceutical 99mTC-MAA with 1.5 millicuries was injected intravenously into both groups. In this study, a significant increase in the red blood cell count of the patient group was observed on the first and second days of the disease. On the third day, this count returned to normal. These changes indicate the functioning of the body's defense system and a response to reduce the complications caused by pulmonary embolism. Therefore, paying more attention to counting red blood cells in pulmonary embolism, along with other care, is recommended due to their particular function.

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Introduction

Pulmonary embolism can be mentioned among the diseases of the respiratory system. There are several ways to diagnose lung emboli (1). One relatively non-invasive method is the nuclear medicine technique called lung scintigraphy (2). A sudden blockage of blood vessels in the lung occurs in this disease. Pulmonary embolism is a severe disease that can cause permanent damage to the lungs, low levels of oxygen in the blood, and damage to other organs in the body due to insufficient oxygen supply (3). Obstruction in the lung's blood vessels prevents the proper exchange of oxygen and carbon dioxide and causes a decrease in blood flow to the lung tissue (4). Of course, the accumulation of platelets, fibrin, and pieces of fat can also be mentioned among other risk factors in developing pulmonary embolism. Blood cell components and some blood factors play a role in developing thrombotic diseases (5).

Diagnosing and properly treating emboli in the lung is very important due to the great importance of this organ and its role in the body's vital functions (6). In lung scintigraphy, a radiopharmaceutical with a specific activity is injected into a vein, absorption of this radiopharmaceutical is done in the lung, and unique cameras show images (5). Examining the changes in blood parameters in pulmonary embolism can affect future treatment decisions. Considering that most of the blood cells are red blood cells, the present study was conducted on red blood cell count in experimental embolic disease and confirmed by scintigraphy in patients (7). Red blood cells are without a nucleus and are concave. In the cytoplasm, there is a pigment called hemoglobin that carries oxygen. These blood cells are surrounded by an elastic plasma membrane so that these cells can change shape and pass through narrow capillaries. In clinical work, counting these blood cells is usually done, and it is considered a helpful blood parameter in blood evaluations (8).

Due to the role and importance of red blood cells, many studies have been conducted on these components in diseases, especially in pulmonary embolisms (8, 9). This study aimed to investigate the possible changes in red blood cell counts caused by embolism in patients by scintigraphy. Hematological factors were also checked for further evaluation.

Materials and Methods

Patients

The current study is a cross-sectional descriptive study. Patients (25 subjects) referred to the hospital with high and moderate clinical suspicion of pulmonary embolism by an internist was included in the study. Clinical suspicion of the disease was established based on Well's criteria (Table 1), which has high validity (10). Also, 25 healthy people were evaluated in the control group.

Scintigraphy

Radiopharmaceutical Technetium ^{99m}Tc albumin aggregated (^{99m}Tc-MAA) with a dose of 1.5 millicuries (mCi) was injected intravenously into control and patient groups. Five minutes after the injection of the radioactive substance, by setting the device's scintillator in the appropriate lung position, a static image was taken according to the

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Table1. Well's criteria for clinical suspicion of pulmonary embolism.

Criteria	Score
Clinical symptoms of deep vein thrombosis	+3
The absence of other diagnostic criteria	+3
Heart rate > 100 per minute	+ 1.5
History of immobility or surgery <4 weeks ago	+ 1.5
Previous history of deep vein thrombosis or pulmonary embolism	+ 1.5
Hemoptysis	+ 1
cancer	+ 1

Note: Score < 2: Low clinical suspicion; Score between 2 and 6: Moderate clinical suspicion; Score > 6: High clinical suspicion.

standard method. This radiopharmaceutical passes through the blood barrier of a healthy lung and accumulates in it according to the blood flow of the lung (2).

In pulmonary embolism, there is a deficiency in the absorption of radioactive radiopharmaceuticals due to inadequate blood supply to the involved organ. Also, the secondary activity of the syringe after the same counter measured the injection to ensure the correct administration of the radiopharmaceutical (3). Due to the same working conditions, the same scintigraphy operation was performed in the control group. In scintigraphy, the amount of radio-drug absorption by an organ is shown by specific defined colors. The color indicates the radiopharmaceutical activity in that part of the body. Color symmetry is also essential in related organs (11).

Laboratory methods

At each stage of blood collection, 2 ml of blood was poured into a tube containing the anticoagulant ethylene diamine tetra-acetic acid (EDTA) to measure hematological factors. A cell counter (21 K) from Sysmex, Japan, was used to measure hematological factors. These factors included hematocrit percentage, hemoglobin, red blood cell count, mean cell volume (MCV), mean cell hemoglobin (MCH), mean cell hemoglobin concentration (MCHC), white blood cell count, and platelet count.

Statistical analysis

ANOVA statistically analyzed the obtained data and interaction slicing with SPSS version 22 and SAS version 9. The obtained numbers were analyzed in the form of a factorial design with two factors, one of the groups under study (control) and (patients) and the other of the study time. Values of $p<0.05$ were reported as significant differences. The Kolmogorov-Smirnov test was used to determine the normality of data distribution. The difference in the data was taken to investigate the effect of factors on the changes in hematological parameters during the studied period. Then an independent one-way analysis of variance was used.

Results

Table 2 shows the statistical description of the obtained data and the comparison between the studied groups. The mean red blood cell count in the control and patient groups obtained by scintigraphy at zero time was 5.73 ± 0.13 and 5.71 ± 0.18 (10^6 cells per microliter), respectively, which was no significant difference between these values. But the number of red blood cells in the control group did not change significantly during different times, but significant changes were seen in the patient group.

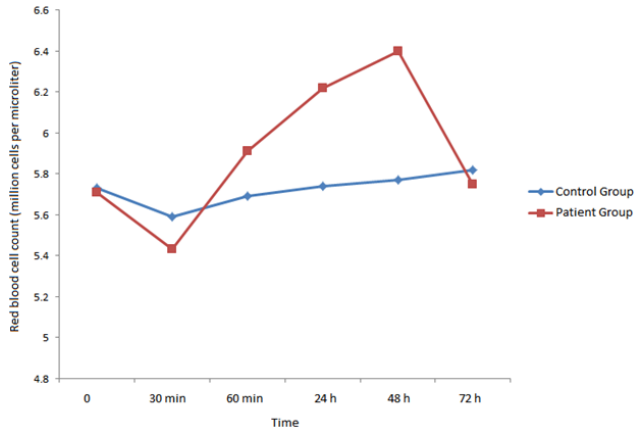

Figure 1. The interaction effect of control and patients groups in the time variable on red blood cell count.

According to Figure 1, the most significant change in the red blood cell count of the patient group was seen in the period of 48 hours after the diagnosis of the embolism. Of course, a slight decrease was observed 30 minutes after the embolism.

On the other hand, all measured hematological factors, except for MCV, showed a significant difference in the control and patient groups, which was consistent with the results of scintigraphy ($p<0.05$) (Table 3).

Discussion

Studying red blood cells is essential because of oxygen supply and involvement in body metabolism in normal conditions and even in diseases (12). The present study was also carried out in line with the importance of these blood cells in pulmonary embolism and diagnostic scintigraphy. The present study observed a significant difference in red blood cell counts between the control and embolism groups regardless of the time under study ($p<0.001$). This trend indicates the presence of changes in this parameter in embolic disease, which is consistent with the findings of others in this field. Also, a significant difference was seen in the red blood cell count between the study periods without considering the groups ($p<0.001$). This problem can indicate the changes that occurred after the embolism, which is in line with the reports of other researchers in this field (13).

A significant difference was observed in examining the interaction of time and embolism factors ($p<0.001$). Due to the significance of the interaction between time factors

Table2. Statistical description of red blood cell counts at different times.

Measurement at different times	Control group (10^6 cell/µl)	Embolism group (10^6 cell/µl)	P-value
0	5.73 ± 0.13	5.71 ± 0.18	0.062
30 min	5.59 ± 0.30	5.43 ± 0.39	0.074
60 min	5.69 ± 0.21	5.91 ± 0.22	0.043
24 hours	5.74 ± 0.14	6.22 ± 0.19	0.011
48 hours	5.77 ± 0.23	6.40 ± 0.15	0.018
72 hours	5.82 ± 0.41	5.75 ± 0.33	0.067

Table 3. Hematological factors between two control and patient groups.

Variable	Control Group	Patient Group	P-value
MCV (μm^3)	86.7 ± 3.7	88.2 ± 5.1	0.067
MCH (pg)	27.4 ± 1.6	30.6 ± 1.3	0.032
MCHC (g/dl)	34.2 ± 1.2	39.1 ± 1.1	0.024
Platelet ($\times 10^9$/L)	195 ± 32	237 ± 56	0.017
White blood cell ($\times 10^{12}$/L)	5.17 ± 0.2	7.1 ± 1.4	0.042

Note: MCV: mean cell volume, MCH: mean cell hemoglobin, MCHC: mean cell hemoglobin concentration.

and embolism, cutting was done for the time factor. Except for the times under study, no significant difference was observed in the rest of the time between the control and embolism groups. In comparing the 60-minute time between the embolism group and the control group, an increase was observed, and this trend was also seen at 24 and 48 hours ($p<0.05$). In the patient group, comparing the zero time data with the 30-minute, 24- and 48-hour time data, and significant difference was observed between the 30-minute time and all the time intervals and between the 60-minute time and the 24- and 48-hour time intervals. Also, a significant difference was seen between 24 and 48 hours with a time interval of 72 hours. A significant difference was observed between the results of 60 minutes, 24, and 48 hours in comparing the patient and control groups. These differences can be caused by the presence of the disease and its process ($p<0.05$). A significant decrease ($p<0.05$) was observed in the number of red blood cells during 30 minutes compared to zero time in the patient group. One of the causes of this reduction can be mentioned in the sampling and volume of blood taken to prepare the clot in the group with embolism. There seems to be no significant difference in the control group during 30 minutes due to the smaller volume of blood taken to prepare the clot. Of course, no significant difference was found between the two groups.

The red blood cell count of the patients showed a significant increase in the period of 60 minutes to 48 hours ($p<0.05$), which is consistent with the findings of others who have raised the increase in the red blood cell count in pulmonary embolism (13). This increase may be because the blood supply decreases with the decrease in blood flow in embolism cases. As a result, the number of red blood cells must be increased to provide sufficient blood supply and oxygen exchange from the lungs. In other words, the lack of oxygen supply is compensated by increasing the number of red blood cells. This increase may be due to time compensation because, in this disease, the time for red blood cells to saturate with oxygen is minimized (14).

Of course, among the conditions that cause embolism and the causes of its exacerbation, we can mention the increase in the number of red blood cells (15). Therefore, in the current study, the increase in red blood cells in the early stages can effectively aggravate embolism. In the present study, the increase in red blood cells, one of the risk factors for causing embolism, decreased during the following times and returned to its average level. This process may be related to the body's adaptation during the lack of oxygen so that if this supply is compensated, it can reduce the risk of embolism formation again. These conditions are critical in treating embolism and reducing risk factors (15). The number of red blood cells in the 72 hours of the group with embolism decreased to the level of the control group. One of its causes is the body's response to a lack of oxygen supply, for example, limiting the need for other organs for oxygen. One of the strong points of this study is the return to the average level of red blood cell count in patients within 72 hours, which, of course, needs more investigation.

This study reveals that the count of red blood cells is essential in pulmonary embolism and the increase and eventually decrease of this value occurs in patients under special conditions and in the defensive and compensatory state of the body, which in turn plays a vital role in the treatment of this disease. Study times should be chosen appropriately due to the transformation of radioactive materials and their persistence in the body. Technetium ^{99m}Tc albumin was used in the current research due to their favorable working conditions and half-life (16). In the case of other radioactive materials, further studies should be done according to the half-life and biological conditions. Scintigraphy is used in various applications, including the diagnosis of embolism. The present study and other reports state the use of nuclear medicine to diagnose pulmonary embolism. In the current study, the control group received the same radiopharmaceutical dose for the same conditions. Therefore, in the foundation of future studies, completely identical environmental conditions should be considered because the change of some factors may affect cellular components (3, 17). Other cases of blood analysis related to red blood cells, such as the determination of red blood cell distribution width and hemoglobin amount, due to the importance of these cells in embolic disease (17). The present study also measured the same. It expresses the importance of checking red blood cells. Finally, it seems that in pulmonary embolism, both increasing and decrea-

sing red blood cell counts play an essential role in stabilizing and compensating for the complications caused by this disease, and it is better. In this disease, counting red blood cells should be done at certain times, and if there is a defect in them, more suitable treatment should be done immediately.

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