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Original Article

The effects of partial hip replacement surgery after hip fractures on complete blood count parameters in elderly

Emrah Sayit[1], Yüksel Terzi[2]

[1]*Department of Orthopaedics, Samsun Education and Research Hospital, Ilkadim, Samsun, Turkey;* [2]*Department of Statistics, Ondokuz Mayis University Faculty of Arts and Sciences, Atakum, Samsun, Turkey*

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Abstract: The aim of this study is to assess the complete blood cell parameters of patients undergoing partial hip replacement surgery due to hip fractures and to analyze and compare the changes in these parameters upon admission to the hospital, after surgery, and before discharge. Twenty-two complete blood count parameters of the 40 patients who underwent partial hip replacement surgery due to hip fracture upon admission to the hospital, 12 hours after surgery, and prior to discharge from the hospital were analyzed and compared. When we compared the hemoglobin, hematocrit, red blood cell (RBC) counts, and the red blood cell distribution width (RDW) between the groups, we found significant differences ($P < 0.05$). Of the parameters relating to the white blood cell (WBC) counts and percentages, most parameters had significant differences ($P < 0.05$). There was a significant difference in only the results of the platelet counts after surgery, and prior to discharge ($P < 0.05$). Analyzing the complete blood count parameters during partial hip replacement surgery due to fractures may help in understanding the physiological effects of the fracture and the procedure. While fractures and hip replacement surgery each cause some changes, hip replacement surgery after fractures does not cause any secondary changes in most blood cells.

Keywords: Hip replacement, complete blood count, hip, hip fracture

Introduction

Partial hip replacement is one of the treatment options for hip fractures in elderly. Efforts to understand the physiology of hip replacements are critical to increasing the success of this type of surgery and to understand and effectively treat complications.

Some changes in the blood parameters may occur as a result of hip replacement surgery [1, 2]. Analyzing these changes may contribute to a number of preventive and protective strategies [3].

A complete blood count is a laboratory test that instantly analyzes the number, percentage, and volume of cells and hemoglobin in the blood. Affected cells and systems can be detected by examining the changes revealed by this test. Some changes occur in the complete blood cell parameters after hip replacement surgery; this is common in all orthopedic surgeries [4]. These changes may be related to the erythrocyte and hemoglobin values due to blood loss or may be related to the white blood cells due to inflammation and infection.

If we evaluate the complete blood count parameters in three main headings: red blood cell (RBC) count, hemoglobin, hematocrit, mean corpuscular hemoglobin (MCH), mean corpuscular volume (MCV), mean corpuscular hemoglobin concentration (MCHC), and red blood cell distribution width (RDW) are related to the red blood cells. WBC, neutrophil, lymphocyte, monocyte, eosinophil, and basophil counts and percentages are related to WBCs. The platelet count, mean platelet volume (MPV), plateletcrit (PCT), and platelet distribution width (PDW) are related to megakaryocytes.

The aim of this study is to assess the complete blood cell parameters of patients undergoing partial hip replacement surgery due to hip fractures and to analyze and compare the changes in these parameters upon admission to the hospital, after surgery, and before discharge.

Table 1. The mean (± sd) level of the parameters related with red blood cells and hemoglobin at the admission, after the surgery, and at the discharge

	At the Admission	After the Surgery	At the Discharge
Hemoglobin (g/dl) (12-16)	11.28 (± 2.69)	10.67 (± 1.59)	10.10 (± 0.74)
Hematocrit (%) (36-46)	34.95 (± 5.99)	32.40 (± 4.35)	30.95 (± 2.60)
RBC (10^6/µl) (3.85-5.22)	3.97 (± 0.83)	3.65 (± 0.58)	3.47 (± 0.55)
MCV (Fl) (80-95)	88.20 (± 7.74)	88.47 (± 6.20)	88.37 (± 5.78)
MCH (pg) (27-34)	29.15 (± 3.53)	28.95 (± 2.66)	28.72 (± 2.10)
MCHC (g/dl) (32-36)	33.00 (± 1.82)	32.72 (± 1.08)	32.50 (± 0.85)
RDW (%) (35.1-46.3)	44.12 (± 4.28)	45.02 (± 5.25)	46.05 (± 5.68)

Table 2. The mean (± sd) count of white blood cells at the admission, after the surgery, and at the discharge

Count of	At the Admission	After the Surgery	At the Discharge
WBC (10^3/µl) (3.7-9.7)	9.55 (± 3.14)	10.35 (± 3.09)	8.40 (± 3.26)
Neutrophil (1.56-6.13)	7.57 (± 2.94)	8.60 (± 2.83)	6.35 (± 2.89)
Lymphocyte (1.3-3.6)	1.22 (± 0.62)	1.00 (± 0.39)	1.15 (± 0.58)
Monocyte (0.2-0.96)	0.62 (± 0.63)	0.57 (± 0.63)	0.62 (± 0.54)
Eosinophil (0-0.5)	0.05 (± 0.22)	0.05 (± 0.22)	0.10 (± 0.38)
Basophil (0-0.2)	0.00 (± 0.00)	0.00 (± 0.00)	0.00 (± 0.00)

Table 3. The mean (± sd) percentage of white blood cells at the admission, after the surgery, and at the discharge

Percentage of	At the Admission	After the Surgery	At the Discharge
Neutrophil (34-71.1)	77.97 (± 8.95)	83.02 (± 6.01)	75.10 (± 8.95)
Lymphocyte (19.4-44.9)	14.25 (± 7.42)	9.67 (± 4.19)	13.85 (± 6.69)
Monocyte (3.3-10.9)	6.30 (± 2.86)	5.70 (± 2.24)	7.80 (± 2.67)
Eosinophil (0.5-7.2)	1.12 (± 1.59)	1.37 (± 1.90)	3.22 (± 4.03)
Basophil (0.1-2)	0.10 (± 0.30)	0.02 (± 0.16)	0.17 (± 0.45)

Materials and methods

This retrospective study was approved by our institutional review board. The study involves 40 randomly selected patients who underwent partial hip replacement surgery due to hip fracture at our hospital. Patients with more than one fracture, developmental hip dysplasia, and any perioperative complications such as thromboembolisms, infections, and iatrogenic fractures were excluded. Priority was given to patients who were operated on at different times by different surgeons.

The complete blood count parameters of the patients upon admission to the hospital, 12 hours after surgery, and before discharge from the hospital were analyzed and compared.

Statistical analysis

The SPSS statistical software package (SPSS, version 20 for Windows; SPSS Inc., Chicago, IL, USA) was used to perform all statistical analyses. Independent t-test was used for the statistical comparison of the parameters. Analysis of variation (ANOVA) with repeated measures was used for the comparison of the WBC, Hb, Hct, Platelet, RBC, and neutrophil values. A value of $P < 0.05$ was considered significant in all statistical analyses. All data were expressed as mean value ± standard deviation.

Results

The mean age of the patients with hip fractures was 78.85 (± 9.00); 28 patients were female and 12 were male. Twenty-one patients had the surgery on the right side, and 19 patients had the surgery on the left side. The average length of hospitalization for these patients was 8.45 (± 2.95) days; the average waiting time before surgery was 2.9 (± 2.12) days; and the average length of stay after surgery was 5.55 (± 1.94)

Table 4. The mean (± sd) level of the parameters related with platelets at the admission, after the surgery, and at the discharge

	At the Admission	After the Surgery	At the Discharge
Platelet (10^3/μl) (140-400)	201.82 (± 59.79)	188.07 (± 66.74)	235.40 (± 98.00)
MPV (fL) (9.4-12.6)	9.75 (± 1.19)	9.75 (± 1.29)	9.75 (± 1.37)
PCT (0.12-0.38)	0.00 (± 0.00)	0.00 (± 0.00)	0.00 (± 0.00)
PDW (9-17)	14.97 (± 1.73)	15.00 (± 1.91)	14.75 (± 2.02)

Table 5. The comparison of the hemoglobin, hematocrit, red blood cell count, red blood cell distribution width, mean corpuscular volume, mean corpuscular hemoglobin, and mean corpuscular hemoglobin concentration levels at the admission, after the surgery, and at the discharge

		p values						
		Hgb	Htc	RBC	RDW	MCV	MCH	MCHC
At the Admission	After the Surgery	.667	**.040**	.078	.503	1.000	1.000	.933
	At the Discharge	**.021**	**.000**	**.000**	**.033**	1.000	.698	.281
After the Surgery	At the Discharge	.064	.086	.440	**.029**	1.000	.389	.423

The significant differences are indicated in bold. Hgb: Hemoglobin, Htc: Hemotocrit, RBC: Red blood cell, RDW: Red blood cell distribution width, MCV: Mean corpuscular volume, MCH: Mean corpuscular hemoglobin, MCHC: Mean corpuscular hemoglobin concentration.

Table 6. The comparison of the white blood cell count, neutrophil, lymphocyte, monocyte, basophil, and eosinophil count and percentage levels at the admission, after the surgery, and at the discharge

		p values										
		WBC	Neut (%)	Lym (%)	Mono (%)	Baso (%)	Eos (%)	Neut (#)	Lym (#)	Mono (#)	Baso (#)	Eos (#)
At the Admission	After the Surgery	.301	**.017**	**.003**	.416	.249	1.000	.117	.144	1.000	1.000	1.000
	At the Discharge	.136	.496	1.000	**.001**	.786	**.003**	.120	1.000	1.000	1.000	.970
After the Surgery	At the Discharge	**.001**	**.000**	**.000**	**.000**	.170	**.001**	**.000**	.170	1.000	1.000	.970

Significant differences are indicated in bold. WBC: White blood cell count, Neut: Neutrophil, Lym: Lymphocyte, Mono: Monocyte, Baso: Basophil, Eos: Eosinophil. %: Percentage, #: Number.

Table 7. The comparison of the platelet, mean platelet volume, platelet distribution width, and plateletcrit levels at the admission, after the surgery, and at the discharge

		Values			
		Plt	MPV	PDW	PCT
At the Admission	After the Surgery	.165	1.000	1.000	1.000
	At the Discharge	.083	1.000	.607	1.000
After the Surgery	At the Discharge	**.002**	1.000	.202	1.000

Significant differences are indicated in bold. Plt: Platelet, MPV: Mean platelet volume, PDW: Platelet distribution width, PCT: Plateletcrit.

days. The average erythrocyte suspension transfusion was 1.55 (± 1.26) units.

We separated the whole blood parameters into three major groups to make a systematic analysis. For the first group, we examined the parameters related to RBCs and hemoglobin (**Table 1**). For the second group, we examined the parameters related to WBCs (**Tables 2** and **3**). For the third group, we examined the parameters related to platelets (**Table 4**).

All parameters related to red blood cells, except MCV, MCH and MCHC showed significant differences between the pre-surgery values and values at discharge ($P < 0.05$) (**Table 5**).

Of the parameters related to WBC counts and percentages, all comparisons, except the eosinophil and basophil counts, showed significant differences ($P < 0.05$) (**Table 6**).

The results of the platelet counts, the MPV, and the PDW upon admission to the hospital, after surgery, and prior to discharge had significant differences, as well ($P < 0.05$). No significant differences were found for the PCT values ($P > 0.05$) (**Table 7**).

Discussion

Many studies have investigated the basic parameters of complete blood counts, such as hemoglobin or WBC counts. However, this study not only analyzed all the parameters of the complete blood count for partial hip replacement surgery patients but also elaborate analysis of all peripoerative blood parameters determined the effects of fracture and hip replacement surgery together.

Hip replacement was associated with one of the most frequent RBC transfusion procedures [5]. In a study by Chen et al., 38.5% of hip replacement patients received an RBC transfusion. They received an average of 1.97 ± 0.14 RBCs [6]. The average erythrocyte suspension transfusion was found 1.55 ± 1.26 units in this study. The hemoglobin, and the hematocrit values were both lower than the normal levels, but RBC was found within normal levels at the admission. They decreased after the surgery as expected, but only the decrease in hematocrit was found significant. They continued to decrease after the surgery until the discharge, but none of them was significant. However, the total decrease from admission to discharge was found significant for all, despite the transfusions. It is revealed that hip surgery after fracture did not cause a secondary fall in these parameters except the hematocrit value, or the fall was balanced with the transfusions.

In a study investigating the clinical importance of the RDW, it was found to be independently associated with an increased risk of short- and long-term mortality following a hip fracture [7]. In this study, it was found that the RDW, which is a marker for hematopoiesis, showed a rising after the fracture from the time of admission until discharge. The increase was only significant after the surgery, but the RDW value never pass the normal levels at any time. It significantly increased at the discharge when compared to the admission. The more increasing in the RDW value after the surgery reveals that the fracture and the surgery together had a synergic affect on inducing new red blood cells, but this process did not occur at the early period. The MCV, MCH and MCHC levels were not affected by the fracture or the surgery and stayed between normal levels at all time.

Although an increase in the WBC count is considered a sign of infection, leukocytosis is common after hip replacement surgery; its specificity is low in terms of infection [8, 9]. In a meta-analysis by Berbari, the WBC count was reported to be at least diagnostically accurate for prosthetic joint infections [10]. An increased WBC count is a risk factor for early mortality, and anemia is a risk factor for late mortality [11]. On the other hand, the lack of an increase in the WBC count may be a risk factor for postoperative delirium in hip fracture patients [12]. The WBC values were found to be elevated after the fracture, but it did not exceed the normal level. It also did not show any significant increase after surgery, but mildly passed over the upper limit. However, it showed a significant decrease after the surgery until the discharge. This situation reveals that the elevated WBC count after the fracture did not have a second peak after the hip replacement surgery. The surgery eliminated the effects that increased the WBC count and made a regression beneath the initial level.

The netrophil levels had a similar course like WBC because nearly 80% of all WBC were neutrophils. Interestingly, the lymphocyte levels were not affected at any time. The neutrophil-to-lymphocyte ratio has been investigated in many studies, and was detected as one of four risk factors for mortality after surgery for hip fractures. Higher risk of infection was found to be associated with a neutrophil-to-lymphocyte ratio higher than five at day five after surgery [13]. This study revealed that patients reacted to the surgery with an increase in neutrophils and a decrease in lymphocytes, which means an increase in the neutrophil-to-lymphocyte ratio. However, at the time of discharge both levels came back to lower values than the admission. When we examined the monocytes, the eosinophils, and the basophils, both of these cells demonstrated a horizontal course. The percentage of the cells showed different characteristics. Where the percentage of lymphocytes, monocytes and basophils decreased with surgery and increased at the discharge, the percentage of neutrophils increased with surgery and decreased at the discharge. Interestingly, the percentage of eosinophils increased with surgery and keeped increasing at the time of discharge.

When we compare the values upon admission to the hospital and before discharge, the effect of the surgery neutralized, but the effect of the fracture was permanent in terms of the neutro-

phil counts. The lymphocyte, monocyte, eosinophil and basophil counts were not affected perioperatively. This reveals that the numbers of white blood cells do not increase or decrease symmetrically. The reason for these different patterns may be the different blood levels of the mediators related to the white blood cells after fracture and surgery.

Many studies have been focused on the platelet counts and its clinical importance. Wong and colleagues found no correlation between platelet count and postoperative deep vein thrombosis [14]. Another study revealed that patients with low or high platelet counts had a higher risk of major or fatal bleeding after acute venous thromboemboli [15]. Monreal claimed that the platelet count levels could be useful to reliably indicate pulmonary embolisms in the very early stages [16]. This study revealed the changes of platelet count and related parameters in complete blood count. We found that the platelet count decreased after surgery but rapidly increased to higher levels than the admission. There was only a significant difference between the post operative values and the values at the discharge. Two different reasons for stress, fracture, and surgery may contribute to a more rapid improvement. Partial hip replacement surgery did not cause any significant fall in the platelets, and the platelet counts never passed the normal limits even after the fracture or the surgery.

There are different views on the clinical importance of the MPV, PCT, and the PDW parameters. One study found that MPV is related to obesity [17]. Li showed that MPV is negatively correlated with bone mineral density in postmenopausal women [18]. In our study, these parameters showed horizontal courses, and did not affected perioperatively. Interestingly, the RDW showed more significant changes than the PDW which meaned the red blood cells gave more rapid response to trauma than the megakaryocytes.

This study investigated and compared the effects of partial hip replacement surgery on 22 complete blood count parameters in elderly patients with hip fractures. Every single blood cell has a unique pattern after fracture and surgery. Exploring the complete blood count parameters as related to hip replacement surgery due to fractures will help to understand the physiological effects of the procedure. While fractures and hip replacement surgery individually cause some changes, hip replacement surgery after a fracture did not cause any secondary changes in most blood cells. More, larger case studies will help us to better understand and manage these processes and to find innovative solutions to the problems.

Disclosure of conflict of interest

None.

Address correspondence to: Dr. Emrah Sayit, Department of Orthopaedics, Samsun Education and Research Hospital, Ilkadim, Samsun 55100, Turkey. Tel: +90 0362 311 15 00; Fax: +90 362 277 88 65; E-mail: dremrahsayit@gmail.com

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