IBEROAMERICAN JOURNAL OF MEDICINE
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Journal homepage: www.iberoamericanjm.tk

Original article

Evaluation of Transfusion-Related Hemodynamic Parameters in Patients with Beta-Thalassemia Major by Ambulatory Blood Pressure Monitoring Method

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ARTICLE INFO

Article history:
Received 22 March 2021
Received in revised form
19 April 2021
Accepted 24 April 2021

Keywords:
Non-dipper
Thalassemia
Transfusion
Blood pressure

ABSTRACT

Introduction: There are very few studies on the effects of regular blood transfusions on the hemodynamic organization of patients with Beta-Thalassemia Major (BTM). Ambulatory Blood Pressure Monitoring is method that evaluates fluctuations in day-night periods and life cycle changes. In this study, we aimed to investigate the effects of blood transfusion on hemodynamic parameters by the Ambulatory Blood Pressure Monitoring method on the day of transfusion in patients with a diagnosis of Beta-Thalassemia Major.

Material and Methods: This study was conducted in patients who were followed up with a diagnosis of BTM between June 2020 and July 2020. The study consisted of 30 patients. The blood pressure of the patients was measured by auscultation method on the morning of the day when they received routine red blood cell transfusion treatments, and the patients were fitted with an Ambulatory Blood Pressure Monitoring device. With Ambulatory Blood Pressure Monitoring, mean systolic blood pressure, diastolic blood pressure, heart rate, mean arterial pressure, values were calculated for each patient. Statistical analysis was performed by the IBM SPSS Statistics 21 package program. The significance limit for the p-value was accepted as <0.05.

Results: There was a significant difference in mean systolic blood pressure and heart rate values between pre-transfusion, transfusion, and post-transfusion periods. In our study, the rate of white coat hypertension was 8.3%, and the rate of masked hypertension was 4.1%. It was observed that 67% of the patients were non-dippers, and the blood pressure burden of one patient was more than 25%.

Conclusions: Measurement of hemodynamic parameters with Ambulatory Blood Pressure Monitoring is the gold standard in terms of detection and follow-up of non-dipper patients, indicating increased cardiovascular risk. In practice, Ambulatory Blood Pressure Monitoring should be used more in the follow-up of chronic patients.

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http://doi.org/10.5281/zenodo.4722801

Evaluación de los parámetros hemodinámicos relacionados con la transfusión en pacientes con beta-talasemia mayor mediante el método de monitorización ambulatoria de la presión arterial

INFO. ARTÍCULO

Historia del artículo:
Recibido 22 Marzo 2021
Received en forma revisada 19 Abril 2021
Aceptado 24 Abril 2021

Palabras clave:
No-dipper
Talasemia
Transfusión
Presión arterial

RESUMEN

Introducción: Existen muy pocos estudios sobre los efectos de las transfusiones de sangre periódicas sobre la organización hemodinámica de los pacientes con Beta-Talasemia Mayor (BTM). La monitorización ambulatoria de la presión arterial es un método que evalúa las fluctuaciones en los períodos diurnos y nocturnos y los cambios en el ciclo de vida. En este estudio, nuestro objetivo fue investigar los efectos de la transfusión de sangre sobre los parámetros hemodinámicos mediante el método de Monitoreo Ambulatorio de la Presión Arterial el día de la transfusión en pacientes con diagnóstico de Beta-Talasemia Mayor.

Material y métodos: Este estudio se realizó en pacientes que fueron seguidos con un diagnóstico de BTM entre junio de 2020 y julio de 2020. El estudio consistió en 30 pacientes. La presión arterial de los pacientes se midió mediante el método de auscultación en la mañana del día en que recibieron los tratamientos de transfusión de glóbulos rojos de manera rutinaria, y los pacientes fueron equipados con un dispositivo de monitoreo ambulatorio de la presión arterial. Con la monitorización ambulatoria de la presión arterial, se calcularon los valores de la presión arterial sistólica media, la presión arterial diastólica, la frecuencia cardíaca y la presión arterial media de cada paciente. El análisis estadístico se realizó mediante el programa de paquete IBM SPSS Statistics 21. El límite de significación para el valor p se aceptó como <0,05.

Resultados: Hubo una diferencia significativa en la presión arterial sistólica media y los valores de frecuencia cardíaca entre los períodos de pretransfusión, transfusión y postransfusión. En nuestro estudio, la tasa de hipertensión de bata blanca fue del 8,3% y la tasa de hipertensión enmascarada fue del 4,1%. Se observó que el 67% de los pacientes eran no dippers y la carga de presión arterial de un paciente era superior al 25%.

Conclusiones: La medición de parámetros hemodinámicos con monitorización ambulatoria de la presión arterial es el estándar de oro en términos de detección y seguimiento de pacientes no dipper, lo que indica un mayor riesgo cardiovascular. En la práctica, la monitorización ambulatoria de la presión arterial debería utilizarse más en el seguimiento de pacientes crónicos.

HOW TO CITE THIS ARTICLE: Mut MA, Türkkan E, Dağ H, Dursun H. Evaluation of Transfusion-Related Hemodynamic Parameters in Patients with Beta-Thalassemia Major by Ambulatory Blood Pressure Monitoring Method. Iberoam J Med. 2021;3(3):187-195. doi: 10.5281/zenodo.4722801.

1. INTRODUCTION

Thalassemias are an autosomal recessive disease group and cause ineffective erythropoiesis as a result of defects in hemoglobin synthesis, leading to microcytic anemia [1]. Although the disease is frequently seen in geographies with limited resources, it has spread too many parts of the world with the effect of global migration and created a global health burden [2]. Thalassemias are classified as Alpha (α), Beta (ß), Gamma (γ), and Delta (δ) Thalassemias according to the affected globin chain gene. The most common type of Thalassemia in our country is Beta Thalassemia (BT) with a frequency of around 2%. Beta Thalassemias develop due to mutation of genes belonging to one or both beta-globin chains [3-5]. As a result of these mutations, beta chains are either not produced, expressed as Beta^{o} (β^{o}), or underproduced and specified as Beta^{+} (β^{+}) [6-8].

Insufficient production and lack of production create a relative excess in alpha chains and thus the erythrocyte membrane is damaged, hemolysis develops and ineffective erythropoiesis occurs in the bone marrow. As a result of hemolytic anemia, BTs clinically classified as; Beta-Thalassemia Major (BTM), which requires frequent transfusions and has a high mortality risk if untreated, Beta Thalassemia Intermedia (BTI), which does not require frequent transfusions and has moderate anemia, and Beta Thalassemia carrier (BTC) with an asymptomatic course or with mild anemia [3, 9, 10]. Blood transfusions performed to prevent and reduce the problems caused by anemia seen in BTM increased the survival of the disease [11]. The hemodynamic effects of blood transfusion are not an area

that has been emphasized much. It is known that cardiovascular risks are increased in patients with BTM [12]. These increased risks may be related to the variability of blood pressure in the patient. In the literature, there is no study investigating the effect of blood transfusion on blood pressure in pediatric patients with a diagnosis of Beta Thalassemia Major. Blood pressure monitoring in people who receive blood transfusion; Ambulatory blood pressure measurement (ABPM) is carried out using the Ambulatory Blood Pressure Monitoring method, which makes hemodynamic measurements intermittently for 24 hours.

These increased risks may be related to the variability of blood pressure in the patient. In the literature, there is no study investigating the effects of blood transfusions on blood pressure in pediatric patients with a diagnosis of BTM. Ambulatory blood pressure monitoring in people who receive blood transfusion is performed by the ABPM method. With this monitoring, hemodynamic measurements are made intermittently for 24 hours. In routine use, this method is recorded for 24 hours to diagnose hypertension and evaluate the effects of antihypertensive treatments [13].

In this study, we aimed to investigate the effect of blood transfusions on hemodynamic parameters by monitoring blood pressures with the ABPM method on the day of erythrocyte transfusion in patients with BTM diagnosis and regularly receiving the transfusion.

2. MATERIAL AND METHODS

The study is a prospective cohort study and it was conducted between June 1, 2020 and July 1, 2020, in Prof. Dr. Cemil Tascioglu City Hospital Child Health and Diseases Clinic, Pediatric Hematology Department. In our hospital, patients up to the age of 24 can be followed up in the Pediatric Hematology outpatient clinic if they wish. Forty patients who were followed up in the Pediatric Hematology Department with a diagnosis of BTM, aged between 1 and 22 years and who were transfused with regular erythrocyte suspensions every 2-4 weeks were included in the study. During the study, 4 (10%) patients were excluded from the study because they continued their follow-up in another center and 6 (15%) patients under the age of three were excluded since they could not tolerate the device. Before the study, ethics committee approval was obtained from the local ethics committee of our hospital with the number 168, dated 12/05/2020. Patients with thalassemia major between the ages of 1-22 years who gave the necessary consents by their families and/or themselves and who were followed up regularly for transfusions were included in the study. Patients whose consent could not be obtained from the patient or his parents, who could not comply with the ABPM method, who developed any transfusion reaction during or after transfusion, and who had any chronic disease other than thalassemia major were excluded from the study.

The patients with BTM diagnosis, who received regular erythrocyte transfusions and accepted to participate in the study, came to our outpatient clinic after breakfast on the day of the erythrocyte transfusion. Demographic characteristics (age, gender, height, and weight) and disease history characteristics (follow-up period) were recorded. After resting for at least 10 minutes in the outpatient clinic, blood pressures were measured by auscultation method with a suitable cuffed aneroid manometer. The average of systolic blood pressure (SBP) and diastolic blood pressure (DBP) values obtained with 3 measurements was calculated. Then, vascular access of the patients was inserted and blood samples were obtained. Hemoglobin and hematocrit levels, platelet count, urea, creatinine, ferritin, sodium, and potassium levels were recorded. After the outpatient blood pressure measurement, the ABPM device (Mobil-O-Graph® PWA, IEM GmbH, Stolberg Germany) was connected to each patient for 24-hour blood pressure monitoring at 09:00 with a blood pressure cuff suitable for the age and arm length after calibration. The patients were recommended to continue their routine eating habits and daily activities during the 24-hour recording period. Transfusion starting and ending times were determined in all patients and recorded on the transfusion paper. On the other hand, patients or their parents were asked to note the hours of sleep and wakefulness to determine the patient's day-night blood pressure measurements. The ABPM device was set to measure every fifteen minutes between 08:00 and 22:00, and every thirty minutes between 22:00 and 08:00. With the in-life blood pressure monitoring method, blood pressures, and heart rates of the patients were monitored and recorded for 24 hours. Mean SBP, DBP, heart rate (HR), and mean arterial pressure (MAP) values were calculated for each patient for 24 hours and for before, during, and after transfusion periods. For pre-transfusion blood pressure and HR values of patients; measurements were performed in the time between the connection of the ABPM device and the start of transfusion. For the post-transfusion period; measurements between the end of the transfusion and the patient's bedtime were accepted. Measurements between the patient's sleep time and the time he woke up in the morning were considered as night measurements. If the total measurements made in each

patient provided less than 70% data, the measurements were repeated. Night measurements of the patients were determined by asking the families about the patient's sleep times. The measurements made were transferred to the computer program after 24 hours. The data obtained through in-life blood pressure monitoring were interpreted considering the age, gender, and height of the child. According to both manual measurements performed in the outpatient clinic and measurements made with ABPM, systolic and/or diastolic BP for children between the ages of 6-13 according to their age, gender and height were considered as normal if <90 percentile, as high blood pressure if between the 90th percentile and the 95th percentile and as hypertension if it was at or above the 95th percentile. For the patients aged 13 and over, BP was normal if <120/<80 mmHg; it was accepted as high blood pressure if BP was 120-129/<80 mmHg; and it was accepted as hypertension if BP was > 130/>80 mmHg [14]. In the blood pressure percentile table arranged according to age, gender, and height, the 24-hour blood pressure burden of the patients was calculated by dividing the number of measurements above 90 percentiles by the total number of measurements. A blood pressure load of 25% indicates that there is hypertension, and if it exceeds 40%, there is a serious risk or development of target organ injury [15, 16]. We evaluated patients with a decrease of 10% or more in blood pressure during the night compared to the daytime period as "dipper", and patients with a decrease of less than 10% or not as a "non-dipper". Patients whose sleep was disturbed due to the device during night sleep were evaluated again. Whitecoat hypertension was defined as the high manual blood pressure measured in the patient due to the stress experienced in the hospital or outpatient clinic and normal blood pressure was detected when evaluated with ABPM. Masked hypertension was defined as the normal measured blood pressure in the hospital with high ABPM measurements [17].

2.1. STATISTICAL ANALYSIS

IBM SPSS Statistics 21 package program was used for statistical analysis. While evaluating the study data, in addition to descriptive statistical methods, the compatibility of the data to normal distribution was evaluated using the Shapiro-Wilk test. According to this test, the skewness and kurtosis values of those who did not show a normal distribution were examined and variables with values between -1.5 and +1.5 were accepted to fit the normal distribution. If the number of times taken into the evaluation of normally distributed data is 3 or more than 3, variance analysis was applied in repeated measurements. If the data showed sphericity, statistical significance was accepted according to the sphericity assumed p-value, if not, according to the greenhouse-geisser p-value. If the measurements in two different periods were to be compared; dependent group t-test was used. Firstly Friedman's analysis was performed for the data that did not distribute normally and were measured for 3 or more than 3 times. The Wilcoxon test was used in the analysis of comparing 2-time frames. In statistical analysis performed in independent groups, independent samples t-test was used if the data were parametric, and Mann Whitney-U test was used if the data were non-parametric. For statistical significance, values with a p-value less than 0.05 were accepted.

3. RESULTS

The study was conducted with, 9 (30%) female and 21 (70%) male, 30 patients. The mean age of the patients was determined as 10.98±6.30 (3-22) years. Other demographic data of study participants are summarized in Table 1.

The mean follow-up period of the patients from the time of diagnosis was 9.72±6.39 (1-21) years. In pre-transfusion laboratory tests; the mean hemoglobin level was 8.47±1.03 (5-9.8) gr/dL and ferritin was measured as 1721.15±1287.22 mcg/L and summarized in Table 2 together with other laboratory parameters.

Table 1. Demographic and anthropometric data of patients

Parameter	Min	Max	Mean±SD
Age	3	22	10.98±6.30
Height (cm)	88	170	130.43±20.01
Weight (kg)	14	75	34.73±17.41
BMI (kg/m^2)	13.22	27.55	19.01±3.05

BMI: Body mass index; SD: Standard deviation.

Considering the average of 3 blood pressure measurements of the patients determined in the outpatient clinic before ABPM; the mean SBP was calculated as 102.01 ± 10.21 (76.67-120.00) mmHg and the mean diastolic blood pressure was found to be 64.30±9.01 (44.00-86.67) mmHg.

Table 2. Laboratory findings of the patients			
Parameter	**Min**	**Max**	**Mean±SD**
Follow up mperiod after the diagnosis (years)	1	21	9.72±6.39
Hemoglobin (gr/dL)	5	9.8	8.47±1.03
Hematocrit (%)	14.1	30.4	25.19±3.19
Platelet count (10^3/mm^3)	150	1000	405.93±258.32
Urea (mg/dL)	14	44	26.77±7.77
Creatinine (mg/dL)	0.13	0.69	0.31±0.14
Ferritin (mcg/L)	161	5141	1721.15±1287.22
Sodium (mmol/L)	135	144	138.7±1.97
Potassium (mmol//L)	3.6	4.9	4.14±0.31
ALT (U/L)	8	109	34.83±27.97
AST (U/L)	18	116	40.6±21.83

AST: Aspartate aminotransferase; ALT: Alanine aminotransferase.

The mean systolic blood pressure, diastolic blood pressure, mean arterial pressure, and heart rate of the patients for 24-hour, day, night, pre-transfusion, transfusion, and post-transfusion periods obtained by ABPM are shown in Table 3. The dipping average of patients was calculated as 8.77±10.42 (-4.05-56.2). Among participants, 66.7% were non-dipper. Again, the mean blood pressure load for the same day was determined as 13.45% ±6.96% (4%-29.5%). With the data obtained from outpatient blood pressure measurements and ABPM measurements, 1 (4.1%) patient was found to have masked hypertension, and 2 (8.3%) patients had white coat hypertension.

When we compare the mean blood pressure and heart rate summarized in Table 4 between pre-transfusion,

Table 3. Ambulatory Blood Pressure Monitoring (ABPM) results of the patients		
Parameter	**Min-Max**	**Mean±SD**
Pre-transfusion SBP (mmHg)	76-136	103.83±13.5
Pre-transfusion DBP (mmHg)	40-83	58.73±9.85
Pre-transfusion MAP (mmHg)	56-107	78.93±9.9
Pre-transfusion HR (pulse/min)	70-132	97.2±15.2
During transfusion SBP (mmHg)	82.5-138.2	104.66±11.86
During transfusion DBP (mmHg)	40.5-82	59.46 ± 9.37
During transfusion MAP (mmHg)	64.6-106.3	80.72±9.3
During transfusion HR (pulse/min)	71-123	94.17±14.2
Post-transfusion SBP (mmHg)	81-144.5	109.74±14.55
Post-transfusion DBP (mmHg)	50-95	61.53±10.21
Post-transfusion MAP(mmHg)	65-118	83.44±10.98
Post-transfusion HR (pulse/min)	64-121	87.96±11.8
Daytime SBP (mmHg)	84.38-137.1	106.36±11.58
Daytime DBP (mmHg)	47.9-79.8	59.82±7.68
Daytime MAP (mmHg)	64.6-106	81.4±8.57
Daytime HR (pulse/min)	32-123	89.75±14.96
Night SBP (mmHg)	60-113.4	96.95±11.44
Night DBP (mmHg)	38-73	55.55±7.6
Night MAP (mmHg)	48-90	74.42±8.65
Night HR (pulse/min)	57-103	78.32±10.18
24-hour SBP (mmHg)	84.3-135.2	103.84±11.49
24-hour DBP (mmHg)	48.4-86.7	59.35±8.45
24-hour MAP (mmHg)	64.9-104.6	79.5±8.41
24-hour HR (pulse/min)	61.9-122	87.2±12.41
24-hour blood pressure load (%)	4-29.5	13.45±6.96
Systolic Dipping (%) *Dipper (n=10, 33.3%)* *Non-dipper (n=20, 66.7%)*	-4.05-56.2	8.77±10.42

SD: Standard deviation; SBP: Systolic blood pressure; DBP: Diastolic blood pressure; MAP: Mean arterial pressure; HR: Heart rate.

transfusion, and post-transfusion periods; there was a significant difference between the mean systolic blood pressure values. When we compared the mean heart rate between these three periods, a significant difference was found in the trend of decreasing.

The mean daytime, night, and 24-hour blood pressure and HR values are shown in Figure 1.

4. DISCUSSION

Alterations in blood pressure on the day of transfusion are probable in patients with thalassemia major. It has been shown that an increase of 10.9% in blood hematocrit level due to transfusion increases viscosity by 20% in people who have had blood transfusions for various reasons. Consequently, the blood flow rate decreases by 16.6%. The body tries to compensate for this decrease by increasing blood pressure or creating vasodilatation [18]. Besides, the increase in the volume load due to transfusion may cause an increase in blood pressure. When transfusion is performed at a volume or rate that exceeds the capacity of the cardiovascular system to cope with the additional volume load due to transfusion, the patient may experience transfusion-related circulatory overload or hypertension [19]. In this study, it was observed that systolic pressure increased and heart rate decreased after transfusion. Also, when ABPM parameters were examined, it was seen that

Table 4. Comparison of mean blood pressure values before transfusion, during transfusion and post-transfusion periods

Parameter	Mean±SD (before transfusion)	Mean±SD (during transfusion)	p value
Systolic blood pressure	103.83±13.5	104.66±11.86	0.616**
Diastolic blood pressure	58.73±9.85	59.46±9.37	0.592**
Mean arterial pressure	78.93±9.9	80.72±9.3	0.124**
Heart rate	97.2±15.2	94.17±14.2	0.031**
Parameter	**Mean±SD (before transfusion)**	**Mean±SD (after transfusion)**	**p value**
Systolic blood pressure	103.83±13.5	109.74±14.55	0.037**
Diastolic blood pressure	58.73±9.85	61.53±10.21	0.271*
Mean arterial pressure	78.93±9.9	83.44±10.98	0.031**
Heart rate	97.2±15.2	87.96±11.8	<0.0001*
Parameter	**Mean±SD (during transfusion)**	**Mean±SD (after transfusion)**	**p value**
Systolic blood pressure	104.66±11.86	109.74±14.55	0.045**
Diastolic blood pressure	59.46±9.37	61.53±10.21	0.719*
Mean arterial pressure	80.72±9.3	83.44±10.98	0.631**
Heart rate	94.17±14.2	87.96±11.8	0.007*

**Wilcoxon; ** Dependent samples t-test.*

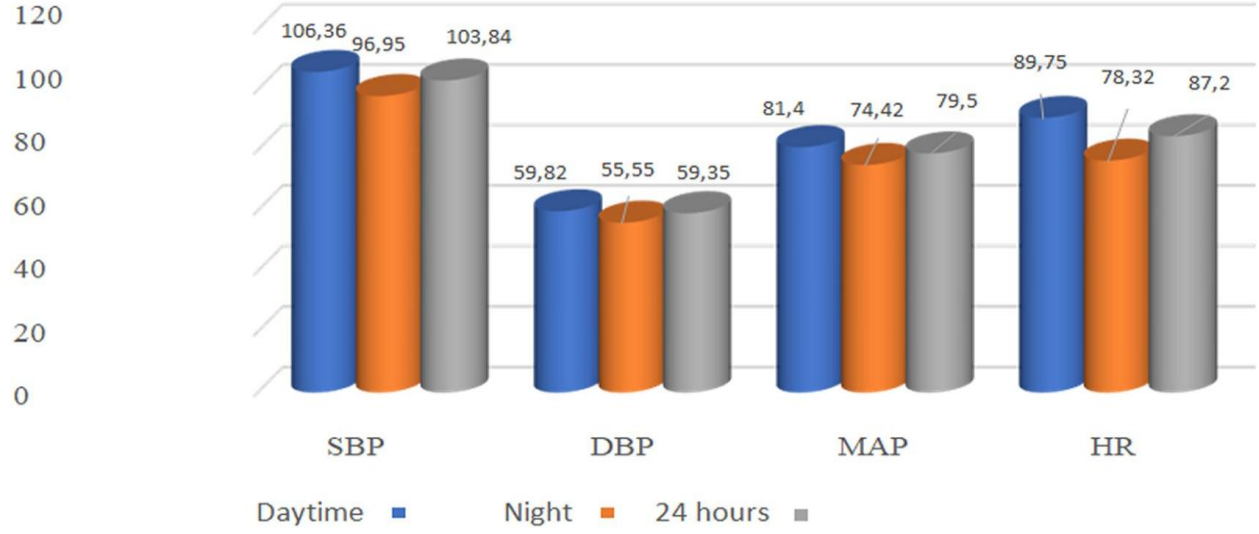

***Figure 1**: 24-Hour Blood Pressure and Heart Rate Parameters.*

the rate of non-dipper patients was high, systolic pressure increased and the heart rate decreased.

In this study, the mean dipping value of the patients was found to be 8.77% and 66.7% of the patients were non-dipper. According to the study of Tabatabaie et al. [20], performed by 24-hour blood pressure measurements with ABPM in Iranian pediatric patients with BTM, 22 (76%) of the patients were non-dipper. However, the difference of study was that hemodynamic factors were evaluated on the day of transfusion. We did not find a similar study in the literature. Therefore, we think that it will shed light on future studies. Vyssoulis et al. [21], in their study comparing anemic and non-anemic patients with BTT patients with a diagnosis of hypertension, found that the dipping values of patients with BTT were higher than the other two groups. In this study, it was seen that 20.4% of patients with BTT were non-dipper [21]. The concepts of dipper and non-dipper are often used in the distinction of primary (essential) hypertension and secondary hypertension. While primary hypertension shows a dipper feature, secondary hypertension reasons show a non-dipper feature. It is known that the risk of ischemic complications increases in patients with excessive "non-dipper" characteristics [22]. However, it is useful to keep in mind that up to 30% of normal children may be "non-dipper" [23]. In some previous studies, it was seen that a fixed time was chosen for night measurements. Therefore, sleep-wake periods could not be differentiated, and therefore, there may be errors in dipping values [20, 24, 25]. In this study, we determined the night-time measurements clearly by recording the sleep time of each child. In this way, we evaluated the dipping values more accurately. We directed the patients with the non-dipper feature to pediatric cardiology for the cardiologic evaluations.

When ABPM parameters were evaluated in the patient group, one of the most important of these was the blood pressure load. Blood pressure load is an important parameter of ABPM and it is predictive for the consequences of hypertension rather than the cause. The relationship of blood pressure load with target organ damage is more pronounced than blood pressure level (24). In the patient group, when the blood pressure load values were examined, we found that only 1 (4.1%) patient's blood pressure load was above 25% and we considered it as hypertensive. In the literature, although the limit of 25% is used as the blood pressure load limit for hypertension, as we generally use, some researchers accept the 15% limit [14, 25].

In this study, we found that the mean SBP values in the post-transfusion period were significantly higher than the period during the transfusion. Besides, we found that the mean SBP in the post-transfusion period was significantly higher than the pre-transfusion period. Contrary to this study, in a study conducted by Veglio et al. in patients with BTM between the ages of 17-19, the blood pressures of the patients were monitored for 24 hours with the ABPM method and they found that systolic blood pressures in patients with BTM were significantly lower than that of healthy individuals [24]. In a study conducted with adult patients hospitalized in the intensive care unit, the effect of blood transfusion on hemodynamic parameters was investigated, and in this study, it was found that systolic blood pressure increased significantly after transfusion. However, the difference was found to be insignificant when the blood pressure measurements performed at the 2nd hour after transfusion were compared with the pre-transfusion period measurements [26]. In a study conducted by Tong et al on preterm infants, they showed that there was no change in systolic blood pressure after blood transfusion [27]. Leipälä et al. [28] also did not detect any change in blood pressure parameters after blood transfusions they performed on preterm infants.

In this study, we did not find a significant difference between the mean DBP values before, during, and after transfusion. In the study conducted by Veglio et al. [24], in patients with BTM, 24-hour blood pressure was monitored with the ABPM method and they showed that DBP was significantly lower than healthy individuals. Saugel et al. [26], found a significant increase in DBP after blood transfusions they performed in adult patients hospitalized in intensive care. However, in a study they conducted with preterm infants, Tong et al. [27] did not find a significant difference in DBP after blood transfusion as in this study.

In this study, we found the mean MAP values in the post-transfusion period significantly higher than that of the pre-transfusion period. In a study conducted by Duke et al. [29], anemic patients and treated anemic patients were compared and they showed that the mean MAP was significantly higher in the anemia-corrected group. Saugel et al. [26] conducted a study in adult patients in the intensive care unit and showed that the increase in MAP after blood transfusion was significant. Veglio et al. [24] showed in their study that in patients with BTM mean arterial pressure was significantly lower than that of the healthy individuals with ABPM

In this study, we found the mean HR values significantly lower in the post-transfusion period compared to the transfusion period. Besides, we found that it was significantly lower during transfusion compared to the pre-transfusion period. In a study conducted by Tong et al.

[27], in preterm infants, they found a significant decrease in HR after blood transfusion. In a study conducted with adult patients, it was shown that the decrease in HR after blood transfusion was significant [26]. A study on preterm infants showed a decrease in HR after blood transfusion, although it was not statistically significant [28]. In the study conducted by Veglio et al., using the ABPM method in patients with BTM, they showed that HR was higher in patients with BTM compared to healthy individuals [24].

In this study, the rate of white coat hypertension was found to be 8.3%. Performing blood pressure measurements in the hospital may cause higher measurements in children than it is, due to adrenergic system activity triggered by anxiety, and this is known as white coat hypertension [17]. Apart from this study, the only study evaluating the issue of white coat hypertension in pediatric patients with BTM was the study of Tabatabaie et al. However, the difference of our study was that; we performed this follow-up on the day of erythrocyte transfusion in patients with BTM. In the study conducted by Tabatabaie et al., with 30 pediatric patients with BTM using the ABPM method; white coat hypertension was found in 6.67% of the patients [20]. In the study conducted by Stabouli et al., in children and adolescents diagnosed with sickle cell anemia (heterozygous s/ß thalassemia) whose blood pressure was monitored with the ABPM method, the rate of white coat hypertension was found as 12.5% [30].

In this study, we found the rate of masked hypertension as 4.1%. Apart from our study, in the study of Tabatabaie et al., they found masked hypertension in 16.7% of the patients [20]. In this study, the frequency of masked hypertension was found to be lower. Studies on masked hypertension in other than patients with thalassemia are available in the literature. In a study conducted with children and adolescents diagnosed with sickle cell anemia (heterozygous s/ß thalassemia), the rate of masked hypertension was found to be 18.8% [30]. In the study conducted by Moodalbail et al., with 56 patients with sickle cell anemia between the ages of 5-20, they followed the blood pressure of the patients for 24 hours with the ABPM method; and 30% of the patients were found to be hypertensive. In 82.3% of these hypertensive patients (24.7% of all patients), masked hypertension was found [31]. Our study is the first study to detect masked and white coat hypertension in Turkish 1-24 age group patients diagnosed with BTM.

The study is the first study in which blood pressure and hemodynamic parameters were monitored on the day of transfusion in the 1-22 age group patients with BTM. Another advantage of this study is that in determining dipper and non-dipper patients, a standard time was not defined for night measurements, but night measurements were determined according to each patient's own sleep time. In this study, we found that white coat hypertension and masked hypertension can also be seen in patients with BTM. However, this study has some limitations. The number of patients is relatively low due to exclusion of patients with additional diseases who are not eligible for the study. Since the determination of the sleep-wake times of the patients is noted by the family, the level of the error made on this issue is unknown. However, sudden waking situations that may be due to the measurement during sleep are not known to us, except during sleep-wake hours. Although the sleeping and waking times can be determined clearly, a standardized sleep that suits every patient during the night may not be possible. Whether device-dependent sleep creates a stress factor is not known. These may have affected dipper/non-dipper rates.

In conclusion; detection of hemodynamic changes with ABPM that cannot be detected by standard measurements will create more chances of diagnosis, treatment, and prevention in selected cases. Studies that will standardize sleep and homogenize patient groups are needed to determine non-dipper rates. Since there are certain centers for transfusion due to beta-thalassemia in Turkey, conducting multi-center studies with large case series and sharing the results will increase our chance of combating complications.

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