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The relationship between mean platelet volume and CURB-65 in predicting hospitalization and 28-day mortality in COVID-19 pneumonia patients admitted to the emergency department

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ABSTRACT

Aims: This study aimed to investigate the combined prognostic value of mean platelet volume (MPV) and CURB-65 scoring in predicting hospital admission status and 28-day mortality among COVID-19 pneumonia patients admitted to the emergency department.

Methods: A prospective observational study was conducted on patients diagnosed with COVID-19 pneumonia in the Adult Emergency Medicine Clinic of Ankara Bilkent City Hospital. Inclusion criteria included polymerase chain reaction (PCR) positivity and characteristic findings on thoracic computed tomography (CT). Clinical, laboratory, and radiological data were collected, and statistical analyses were performed using SPSS 22.0. ROC curve analysis evaluated the prognostic performance of MPV and CURB-65.

Results: Among 500 patients included in the study (55.8% male, mean age: 64±14 years), 49 (9.8%) patients died within 28 days. Higher CURB-65 scores and MPV levels were significantly associated with increased 28-day mortality ($p<0.001$ and $p=0.019$, respectively). Comorbidities such as coronary artery disease, hypertension, cancer, heart failure, and stroke history were also significant predictors of mortality ($p<0.05$). Patients with CURB-65 scores ≥3 and elevated MPV values had a markedly increased mortality risk. Moreover, thoracic CT findings such as diffuse infiltration and consolidation correlated significantly with poor outcomes ($p=0.017$ and $p=0.001$, respectively).

Conclusion: The combined use of CURB-65 and MPV offers a valuable tool for predicting 28-day mortality in COVID-19 pneumonia patients. These findings suggest the need for further studies to validate the utility of this combined approach in clinical practice.

Keywords: COVID-19, CURB-65, mean platelet volume, mortality prediction, emergency department

INTRODUCTION

In December 2019, the process that started with an increase in pneumonia cases of unknown cause in Wuhan, China, moved to a different dimension with the identification of a new coronavirus strain in January 2020. The disease caused by this virus, called severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2), was declared a pandemic by the World Health Organization (WHO) in March 2020. COVID-19 has a wide spectrum of clinical manifestations, ranging from mild upper respiratory tract infection to acute respiratory distress syndrome (ARDS) and death.[1]

COVID-19 pneumonia has a special place among viral pneumonias and a significant proportion of patients are hospitalized due to respiratory failure. Comorbid conditions such as advanced age, hypertension (HT), diabetes mellitus (DM), chronic obstructive pulmonary disease (COPD), cardiovascular diseases and malignancies increase the mortality risk of the disease. Accurately predicting the intensive care needs and mortality risk of COVID-19 patients is critical to ensure the effective use of limited health resources.[2-5]

The CURB-65 score is a widely used clinical scoring system to assess mortality and prognosis in pneumonia patients. Mean platelet volume (MPV) is a hematologic parameter evaluated as an indicator of inflammation and thrombotic processes.

In this study, we investigated the predictive power of the combined use of MPV and CURB-65 score on hospitalization and 28-day mortality in COVID-19 pneumonia patients admitted to the emergency department. With this study, it is planned to reduce the length of time patients stay in the emergency department, determine which patients need intensive care, and thus reduce the emergency department workload.

METHODS

The study was initiated with the approval of the Ankara Bilkent City Hospital Clinical Researches Ethics Committee (Date: 11.11.2020, Decision No: 1283). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

This study is planned as a retrospective, cross-sectional diagnostic accuracy study. This study was conducted with a prospective observational design in patients admitted to Ankara Bilkent City Hospital Adult Emergency Medicine Clinic and diagnosed with COVID-19 pneumonia. Inclusion criteria included the presence of COVID-19 pneumonia findings on thoracic computed tomography (CT) and confirmation of infection by polymerase chain reaction (PCR) testing.

In addition to clinical, laboratory and radiologic findings, CURB-65 score and the use of MPV were evaluated in relation to the place of hospitalization and 28-day mortality.

Inclusion Criteria

- Presenting to the emergency department with COVID-19 symptoms
- To be 18 years of age or older
- Having a viral pneumonia image with CT
- Positive PCR test for COVID-19

Exclusion Criteria

- Patients under 18 years of age
- Patients presenting to the emergency department in cardiac arrest

Statistical Analysis

The data obtained were analyzed with SPSS 22.0 software. Categorical data were evaluated with Chi-square test, while Independent sample t-test or Mann-Whitney U test were used for continuous variables. ROC curve analysis was performed to determine the prognostic value of CURB-65 and MPV and statistical significance level was accepted as $p<0.05$.

RESULTS

The findings obtained to evaluate the effect of MPV and CURB-65 score on predicting 28-day mortality and hospitalization in patients admitted to the emergency department, diagnosed with COVID-19 infection, PCR test positive and lung involvement on thorax CT were presented in tables in line with statistical analyses.

As shown in Table 1, 279 (55.8%) of the patients were male and 221 (44.2%) were female in our study in which a total of 500 patients were evaluated. Of the 500 patients, 49 (9.8%) died within 28 days and 451 (90.2%) did not die within 28 days. According to the results of our study, 7.7% of female and 11.5% of male patients died. There was no statistically significant difference between the mortality groups in terms of gender distribution ($p=0.158$).

Table 1. Relationship between gender and mortality*

		Total		28 days mortality				
				No		Yes		
		n	Collumns, %	n	Line, %	n	Line, %	p value
Total		500	100.0%	451	90.2%	49	9.8%	
Gender	Male	279	55.8%	247	88.5%	32	11.5%	0.158
	Female	221	44.2%	204	92.3%	17	7.7%	

*Chi-square test

In our study, the age factor was statistically significant in terms of 28-day mortality ($p<0.01$) and is shown in Table 2. The mean age of the patients included in our study was 64±14 years. In patients who did not die within 28 days, the mean age was 63±14 years, and in the group of patients who died within 28 days, the mean age was 75±10 years, and the difference was statistically significant ($p<0.001$).

As shown in Table 3, the comorbidities of the patients and their effect on 28-day mortality were also analyzed in our study. As a result of the statistical analyses, the presence of CAD, HT, cancer/immunosuppression, CHF and LVO were found to be significant in terms of 28-day mortality ($p<0.05$). In our study, 103 (20.6%) patients had CAD and 20 (19.4%) of these patients died within 28 days. HT was diagnosed in 249 (49.8%) patients and 32 (12.9%) of these patients died within 28 days. 54 (10.8%) of 500 patients had a history of cancer/immunosuppression and 11 (20.4%) of these patients had a mortal course of Covid-19 within 28 days. Thirty (6%) patients were diagnosed with CHF and 7 (23.3%) of these patients died within 28 days. Of the 500 patients included in the study, 21 (4.2%) had a history of LVO and 8 (38.1%) of these 21 patients died within 28 days.

Table 4 shows the relationship between the hematologic findings of the patients included in the study and mortality. Among the hematologic findings, RBC, HGB, RDW, NLR and MPV were statistically significant in terms of 28-day mortality ($p<0.05$)

The relation of complete blood count parameters with the place of hospitalization is shown in Table 5. Among these parameters, RBC, HGB, PLT, RDW, MPV and NLR were statistically different between the groups in the ward-intensive care unit follow-up ($p<0.05$).

CT findings of the patients and their relationship with mortality are shown in Table 6. 343 (68.6%) patients had diffuse infiltration on CT and 41 (12%) of these patients died within 28 days, and the finding of diffuse infiltration on CT was statistically significant in terms of 28-day mortality ($p=0.017$). 154 (30.8%) patients had consolidation on CT and 25 (16.2%) of these patients died within 28 days, the finding of consolidation was statistically significant in terms of 28-day mortality ($p=0.001$). It was observed that 32 (6.4%) of the patients included in the study had pleural effusion and 8

Table 2. Mortality and age relationship*

	Total							28 days mortality													
								Yes							No						
	Mean	SD	Med	25	75	Min	Max	Mean	SD	Med	25	75	Min	Max	Mean	SD	Med	25	75	Min	Max	p value
Age	64	14	65	55	74	19	98	63	14	63	53	73	19	98	75	10	74	67	83	49	92	<0.001*

*Mann Whitney-U test, and *Independent samples-t test, SD: Standard deviation, Med: Median, Min: Minimum, Max: Maximum

Table 3. Mortality and comorbidity*

		Total		28 days mortality				
				No		Yes		
		n	%	n	%	n	%	p value
Total		500	100.0%	451	90.2%	49	9.8%	
Coronary artery disease	No	397	79.4%	368	92.7%	29	7.3%	<0.001
	Yes	103	20.6%	83	80.6%	20	19.4%	
Respiratory disease (asthma, chronic obstructive pulmonary disease)	No	434	86.8%	393	90.6%	41	9.4%	0.496
	Yes	66	13.2%	58	87.9%	8	12.1%	
Diabetes mellitus	No	342	68.4%	306	89.5%	36	10.5%	0.422
	Yes	158	31.6%	145	91.8%	13	8.2%	
Hypertension	No	251	50.2%	234	93.2%	17	6.8%	0.022
	Yes	249	49.8%	217	87.1%	32	12.9%	
Chronic kidney disease	No	468	93.6%	424	90.6%	44	9.4%	0.227*
	Yes	32	6.4%	27	84.4%	5	15.6%	
Cancer/immunosupressed	No	446	89.2%	408	91.5%	38	8.5%	0.006
	Yes	54	10.8%	43	79.6%	11	20.4%	
Congestive heart failure	No	470	94.0%	428	91.1%	42	8.9%	0.020*
	Yes	30	6.0%	23	76.7%	7	23.3%	
Cerebrovascular accident	No	479	95.8%	438	91.4%	41	8.6%	<0.001*
	Yes	21	4.2%	13	61.9%	8	38.1%	

*Chi-square test, and *Fisher's exact test

Table 4. Association of complete blood count with mortality*

	Living					Exitus					
	Mean	SD	Med	Min	Max	Mean	SD	Med	Min	Max	p value
WBC	6.9	3.7	6.0	.9	34.5	7.9	6.4	7.1	1.0	45.8	0.266
NEU	5.4	3.5	4.3	.5	33.0	6.4	6.4	5.2	.1	44.1	0.296
LYM	1.1	2.3	.9	.2	48.0	1.0	.5	.9	.2	2.6	1.000
LYM%	16.9	9.7	15.8	.3	55.0	17.0	12.6	16.3	1.4	76.6	0.752
RBC	4.63	.66	4.67	2.02	8.80	4.32	.79	4.38	2.28	6.35	0.002
HGB	13.2	1.9	13.4	5.1	19.5	12.2	2.4	12.3	7.6	17.5	0.003
PLT	225	101	210	7	924	216	96	218	27	415	0.719
RDW	14.2	1.6	13.8	11.3	22.2	15.2	2.0	14.8	13.1	23.1	<0.001
MPV	8.5	1.0	8.3	6.6	16.4	8.8	.9	8.6	7.6	11.6	0.019
DNI	1.4	2.7	.1	0.0	19.3	1.9	3.4	.4	0.0	17.5	0.198
NLR	6.98	7.14	4.44	0.00	54.93	14.52	14.51	9.43	2.22	70.05	<0.001

*Mann Whitney-U test, SD: Standard deviation, Med: Median, Min: Minimum, Max: Maximum, WBC: White blood count, NEU: Neutrophyl, LYM: Lymphocyte, RBC: Red blood count, HGB: Hemoglobin, PLT: Platelet, RDW: Red cell distribution width, MPV: Mean platelet volume, NLR: Neutrophyl to lymphocyte ratio

(25%) of these patients died within 28 days, and the finding of pleural effusion was statistically significant in terms of 28-day mortality (p=0.008). It was determined that 39 (7.8%) of the patients included in the study had mediastinal lymphadenopathy (LAP) on CT and 8 (20.5%) of these patients died within 28 days, and the finding of LAP on CT was statistically significant in terms of mortality (p=0.042).

In Table 7, the relationship between CURB-65 score and mortality was analyzed. The grouping of the patients included in the study according to the CURB-65 score was 465 (93%) patients in the mild-moderate risk group and 35 (7%) patients in the high-risk group. While 27 (5.8%) of the patients in the mild-moderate risk group died within 28 days, 22 (62.9%) of the patients in the high-risk group died within 28 days and

Table 5. Association of complete blood count with place of hospitalization*

	Follow-up type														
	Service							Intensive care unit							p value
	Mean	SD	Med	25	75	Min	Max	Mean	SD	Med	25	75	Min	Max	
WBC	6.9	3.8	5.9	4.5	8.2	1.2	34.5	7.2	4.8	6.2	4.7	8.1	.9	45.8	0.722
NEU	5.4	3.5	4.3	3.1	6.9	.6	33.0	5.7	4.7	4.6	3.1	6.9	.1	44.1	0.775
LYM	1.1	2.5	.9	.6	1.3	.2	48.0	1.0	.5	.9	.7	1.2	.2	3.4	0.958
LYM%	16.8	9.8	15.8	9.2	22.1	.3	55.0	17.0	10.5	16.2	9.4	22.4	1.4	76.6	0.871
RBC	4.64	0.61	4.67	4.33	5.01	2.02	7.22	4.51	0.82	4.59	4.02	4.92	2.28	8.80	0.035
HGB	13.2	1.8	13.4	12.2	14.4	5.9	17.5	12.8	2.4	12.9	11.3	14.5	5.1	19.5	0.048
PLT	219	98	205	157	261	7	924	239	104	232	160	299	26	664	0.025
RDW	14.0	1.5	13.7	13.0	14.6	11.3	21.5	14.8	1.9	14.5	13.5	15.7	11.3	23.1	<0.001
MPV	8.5	1.0	8.3	7.8	8.9	6.6	16.4	8.7	0.9	8.6	8.1	9.1	6.9	11.6	<0.001
DNI	1.3	2.8	.1	.0	1.5	.0	19.3	1.6	2.8	.4	.0	2.1	.0	17.9	0.141
NLR	5.81	5.52	4.01	2.62	6.59	.00	45.29	12.53	11.94	8.84	4.56	15.13	.87	70.05	<0.001

*Mann Whitney-U test, SD: Standard deviation, Med: Median, Min: Minimum, Max: Maximum, WBC: White blood count, NEU: Neutrophyl, LYM: Lymphocyte, RBC: Red blood count, HGB: Hemoglobin, PLT: Platelet, RDW: Red cell distribution width, MPV: Mean platelet volume, NLR: Neutrophyl to lymphocyte ratio

Table 6. Association of CT findings with mortality

		28 days mortality				p value
		No		Yes		
		n	%	n	%	
CT- ground glass	No	12	92.3%	1	7.7%	1.000*
	Yes	439	90.1%	48	9.9%	
Diffuse infiltration	No	149	94.9%	8	5.1%	0.017
	Yes	302	88.0%	41	12.0%	
Consolidation	No	322	93.1%	24	6.9%	0.001
	Yes	129	83.8%	25	16.2%	
Pleural effusion	No	427	91.2%	41	8.8%	0.008*
	Yes	24	75.0%	8	25.0%	
Crazy-paving	No	396	90.8%	40	9.2%	0.219
	Yes	55	85.9%	9	14.1%	
LAP	No	420	91.1%	41	8.9%	0.042*
	Yes	31	79.5%	8	20.5%	
Pericardial effusion	No	448	90.3%	48	9.7%	0.339*
	Yes	3	75.0%	1	25.0%	
Air bronchogram	No	433	90.8%	44	9.2%	0.064*
	Yes	18	78.3%	5	21.7%	

Chi-square test, *Fisher's exact test, CT: Computed tomography, LAP: Lymphadenopathy

the CURB-65 score was statistically significant in predicting 28-day mortality (p<0.001).

As shown in Table 8, when the association of MPV and CURB-65 with mortality was analyzed, the mean MPV value was 8.4 fl in the group with 0 CURB-65 points, 8.5 fl in the group with 1 point, 8.7 fl in the group with 2 points, 9 fl in the group with 3 points, 8.6 fl in the group with 4 points and 8.9 fl in the group with 5 points. This difference between the groups was found to be statistically significant in terms of mortality and the difference was found to be due to the 0-2nd and 0-3rd groups (p=0.001). Among the CURB-65 risk groups, the mean MPV in the high-risk group was 8.9 fl, while the mean MPV in the mild-moderate risk group was 8.5 fl, which was statistically significant in terms of mortality (p=0.003).

DISCUSSION

In our study, when the effect of gender factor on mortality was analyzed statistically, no significant difference was found (p=0.158). Although the mortality rate of men was higher than that of women, this difference was not statistically significant. Similar to our study in the literature, Liu et al.[6] conducted a study with 10.948 patients and showed that men were more susceptible to COVID-19 disease than women, but there was no significant relationship in terms of mortality.

Table 7. CURB-65 mortality association

		Total		28 days mortality				
				No		Yes		
		n	Column, %	n	Line, %	n	Line, %	p value
CURB-65	0	179	35.8%	176	98.3%	3	1.7%	<0.001*
	1	152	30.4%	150	98.7%	2	1.3%	
	2	134	26.8%	112	83.6%	22	16.4%	
	3	19	3.8%	11	57.9%	8	42.1%	
	4	9	1.8%	2	22.2%	7	77.8%	
	5	7	1.4%	0	0.0%	7	100.0%	
CURB-65 risk	Light-moderate	465	93.0%	438	94.2%	27	5.8%	<0.001*
	High	35	7.0%	13	37.1%	22	62.9%	

CURB-65: Confusion, uremia, elevated respiratory rate, hypotension, and aged 65 years or older, Chi-square test, *Fisher's exact test

Table 8. Association of CURB-65 and MPV with mortality

		MPV					p value
		Mean	SD	Median	Percentile 25	Percentile 75	
CURB-65	0	8.4	1.0	8.2	7.8	8.8	0.001*
	1	8.5	.9	8.4	7.9	9.0	
	2	8.7	1.0	8.5	8.1	9.3	
	3	9.0	.7	9.0	8.5	9.3	
	4	8.6	.9	8.9	7.8	9.5	
	5	8.9	.7	9.0	8.2	9.6	
CURB-65 risk group	Light-median risk	8.5	1.0	8.3	7.9	9.0	0.003**
	High risk	8.9	.7	9.0	8.2	9.5	

*Kruskall-Wallis test, * Subgroups were evaluated by Bonferroni analysis; the difference is due to differences between groups 0-2 and 0-3. **Mann Whitney-U test, CURB-65: Confusion, uremia, elevated respiratory rate, hypotension, and aged 65 years or older, MPV: Mean platelet volume, SD: Standard deviation

This may be explained by the fact that age and comorbid conditions are also effective on the mortality of patients along with gender.

In our study, when the mean age of patients who died within 28 days and patients who did not die were analyzed, it was observed that the mean age of patients with mortality was significantly higher and the age factor was statistically significant in terms of mortality (p<0.001). In the cohort analysis conducted by Banerjee et al.[7] in correlation with our study in the literature, it has been shown that age is one of the leading individual risk factors for COVID-19, and the risk of death increases exponentially, especially in individuals over 70 years of age, if comorbidities are also present. In addition, in the study by Williamson et al.[8] it was shown that mortality was lower in patients below the age of 50 years, whereas mortality increased exponentially in each decade above the age of 50 years.

The comorbidities of the patients included in our study and their relationship with mortality were analyzed. In the patients included in our study, the presence of CAD, HT, cancer/immunosuppression, LVO, and CHF in the history was found to be statistically significant in terms of 28-day mortality. Many studies also support our results.

In our study, a significant difference was found between CURB-65 score and mortality (p<0.001). In the literature, in parallel with our study, Zhou et al.[9] showed that the CURB-65 score was significantly higher in patients who died. Again, in parallel with our study, Satici et al.[10] showed that CURB-65 score had 73% sensitivity and 85% specificity in predicting 30-day mortality in patients with a CURB-65 score of 2 and above. We think that the CURB-65 score is significant in terms of determining the need for intensive care and predicting mortality in patients with COVID-19 pneumonia.

When the hematologic findings of the cases were examined in our study, MPV (p=0.019), RBC (p=0.002), HGB (p=0.003), RDW (p<0.001), NLR (p<0.001) values were statistically significant in terms of 28-day mortality. In the literature, in correlation with our study, Henry et al.[11] showed that RDW was a useful predictor of morbidity and mortality in a wide range of conditions including sepsis, pneumonia and other respiratory diseases. Again, in correlation with our study, Güçlü et al.[12] showed that severe COVID-19 was associated with low HGB values and RDW was correlated with the severity of COVID-19.

In our study, it was found that the increase in MPV values was associated with mortality and MPV values were higher in intensive care unit patients. Again in the literature, in correlation with our study, Güçlü et al.[12] reported that the decrease in PLT count and increase in MPV were associated with mortality in COVID-19 patients. Similarly, in the study conducted by Ceyhan et al.[13] it was shown that MPV values increased in intensive care unit patients and were statistically significant in terms of mortality. Increased MPV values are said to be the hallmark of various thrombotic disorders including acute coronary syndrome, stroke, VTE, abdominal vein thrombosis, and even preeclampsia. Since COVID-19 infection also causes an increased rate of thrombotic processes, it is thought that increased MPV values may be a poor prognostic marker. As a result of this study, we think that MPV can be used as a marker of poor prognosis and a predictor of mortality.

In our study, when the CT findings of the patients were analyzed, it was observed that the finding of diffuse infiltration was associated with mortality. Normally, we do not expect central involvement in COVID-19 patients and if central involvement is observed in patients with COVID-19, we may think that the disease has a severe course and secondary bacterial infection may have developed if clinically and laboratory findings support this. Therefore, we think that this involvement may be associated with mortality.

In our study, the finding of consolidation on CT was found to be significant in terms of 28-day mortality (p=0.001). In the literature, in correlation with our study, Li et al.[14] reported that the finding of consolidation on CT was a finding indicating that the disease was progressing and that it would indicate a severe course of the disease.

In our study, when CURB-65 score and MPV values of the patients were analyzed together, it was observed that elevated CURB-65 and MPV were significant in terms of mortality. While CURB-65 score and MPV were found to be predictive of mortality individually, their combined use was found to be statistically significant in terms of predicting mortality. In the literature, similar to our study, Gölcük et al.[15] showed that CURB-65 score was independently predictive of mortality in community-acquired pneumonia and its correlation with MPV was more effective in predicting 28-day mortality.

CONCLUSION

There are also many studies in the literature examining MPV in COVID-19 and CURB-65 score in COVID-19, but there is no study on the use of both together. With this study, we think that the combined use of MPV and CURB-65 score can be used as a predictor of mortality in COVID-19 pneumonia, but more studies are needed in this sense.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was initiated with the approval of the Ankara Bilkent City Hospital Clinical Researches Ethics Committee (Date: 11.11.2020, Decision No: 1283).

Informed Consent

All patients signed and free and informed consent form.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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Original Article

FGF-21 as a potential biomarker for coronary artery calcification: a non-invasive approach

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ABSTRACT

Aims: The aim of this study was to investigate the relationship between fibroblast growth factor 21 (FGF-21) levels and coronary artery calcium (CAC) scores calculated using the Agatston method, and to evaluate the potential of FGF-21 as a non-invasive biomarker for the assessment of coronary artery calcification.

Methods: A total of 54 adult individuals who had undergone coronary CT angiography within the past three months solely for cardiovascular risk assessment were prospectively included in the study. Serum FGF-21 levels were measured using the ELISA method, and CAC scores were determined via the Agatston scoring system. The relationship between FGF-21 levels and CAC scores was analyzed using Spearman's correlation test.

Results: A significant and strong positive correlation was observed between FGF-21 levels and CAC scores ($r=0.725$, $p<0.001$). Diabetes mellitus and hyperlipidemia were significantly associated with higher CAC scores ($p=0.006$ and $p=0.024$, respectively), whereas their associations with FGF-21 levels were not statistically significant ($p=0.065$ and $p=0.104$). No significant correlations were found between FGF-21 levels and other variables such as age, gender, hypertension, or biochemical parameters.

Conclusion: The findings suggest that serum FGF-21 levels may be associated with coronary artery calcification and could serve as a non-invasive and easily applicable biomarker in individuals for coronary artery disease. FGF-21 may be particularly useful in clinical settings where access to advanced imaging modalities is limited.

Keywords: FGF-21, coronary calcium score, atherosclerosis, biomarker, non-invasive evaluation

INTRODUCTION

Fibroblast growth factor 21 (FGF-21) is a hormone secreted by hepatocytes and has a regulatory effect on different tissues, including cardiomyocytes, immune cells, and fibroblasts. By acting on energy metabolism, oxidative stress, fibrosis, and inflammation; FGF-21 has been shown to be a possible cardioprotective molecule.[1]

FGF-21 has been shown in studies to play a protective role in several cardiovascular diseases, including MI, diabetic cardiomyopathy, and atherosclerosis.[2-4] In addition, FGF-21 levels help to predict the prognosis of many heart diseases, such as MI, hypertension, and cardiomyopathy.[5,6]

Vascular calcification is an advanced stage of atherosclerotic plaque formation and serves as a marker that indicates an increased risk of cardiovascular events.[7]

FGF-21 plays a key role in energy balance and lipid and glucose metabolism. Its levels rise in conditions like obesity, type 2 diabetes, and metabolic syndrome—major risk factors for cardiovascular disease—linking elevated FGF-21 to increased cardiovascular risk.[8]

FGF-21 is thought to protect against atherosclerosis by regulating several cellular events. It may attenuate endothelial dysfunction through multiple pathways. For example, co-culture of human umbilical cord vascular endothelial cells

(HUVECs) with FGF-21 delayed endothelial senescence by increasing silent information regulator 1 (SIRT1).[9]

An in vitro study explored the impact of FGF-21 on HUVEC pyroptosis triggered by oxidized low-density lipoprotein. The results revealed that FGF-21 could suppress HUVEC pyroptosis through the involvement of reactive oxygen species and specific protein pathways.[10] In apolipoprotein E-/- (apoE-/-) mice, FGF-21 was found to reduce endothelial apoptosis by inhibiting the Fas signaling pathway.[11] Moreover, FGF-21 exerts its effects by inhibiting the NLRP3 inflammasome pathway.[12] Additionally, an in vivo study demonstrated that FGF-21 alleviates atherosclerosis by inhibiting the NF-κB pathway in endothelial cells.[13]

In vitro studies show that FGF-21 inhibits foam cell formation and macrophage apoptosis, offering protection against atherosclerosis. It enhances cholesterol efflux by inducing autophagy, upregulating ATP-binding cassette transporters A1 and G1 pathways.[14-18]

In mice treated with a high-fat diet and low-dose streptozotocin, FGF-21 inhibits the migration and proliferation of vascular smooth muscle cells.[19] Additionally, FGF-21 can promote the secretion of adiponectin, which exerts an atheroprotective effect by reducing endothelial dysfunction. This mechanism prevents the conversion of macrophages into foam cells and inhibits the proliferation of vascular smooth muscle cells.[20] Administration of recombinant human FGF-21 (rhFGF21) has been shown to protect against atherosclerotic plaque formation.[21]

In mice, treatment with an FGF-21 analog resulted in a reduction of atheromatous plaques and a decrease in lipid levels.[22] Additionally, the application of rhFGF21 in mice has been shown to reduce the severity of atherosclerotic lesions and increase the stability index.[23]

CAC score is a valuable tool for cardiovascular risk assessment but requires imaging methods like CT angiography, which involve radiation, cost, and limited accessibility. Since FGF-21 is linked to metabolic activity and vascular remodeling, this study investigated whether serum FGF-21 levels are associated with CAC scores (Agatston method) to explore its potential as a biomarker for coronary calcification.

METHODS

All procedures were approved by the Ethics Committee of Ankara Bilkent City Hospital (Date: 29.05.2024, Decision No: TABED 2/209/2024) and were carried out in accordance with the principles of the Declaration of Helsinki. This prospective study was conducted at Ankara Bilkent City Hospital between May 29, 2024 and November 29, 2024. A total of 103 patients who had undergone coronary computed tomography angiography (CTA) within the previous three months and presented to the internal medicine outpatient clinic were evaluated. Of these, 54 adult patients who met the inclusion criteria were enrolled in the study (**Figure 1**). Patients included in the study had no active coronary symptoms, electrocardiographic changes, or clinical signs of acute myocardial infarction. Coronary CTA had been performed within the prior three months solely for cardiovascular risk assessment purposes. No patient underwent invasive coronary angiography. Demographic characteristics, medical history, and biochemical data were recorded for all participants. Individuals with chronic kidney disease, alcohol addiction, a history of coronary artery stenting or revascularization, coronary artery bypass surgery, or malignancy were excluded from the study. Coronary CT images were retrieved from the hospital imaging system and evaluated by a single radiologist. Coronary artery calcium (CAC) scores were calculated using the Agatston method, which is commonly applied in both clinical and research settings to quantify coronary calcification and stratify cardiovascular risk.[24] Venous blood samples were collected in the morning after overnight fasting. Serum levels of FGF-21 were measured using a sandwich enzyme-linked immunosorbent assay kit (SEC918Hu96, species: *Homo sapiens*), intended for research use only. The assays were performed at the Central Biochemistry Laboratory of Ankara Bilkent City Hospital in accordance with the manufacturer's instructions.

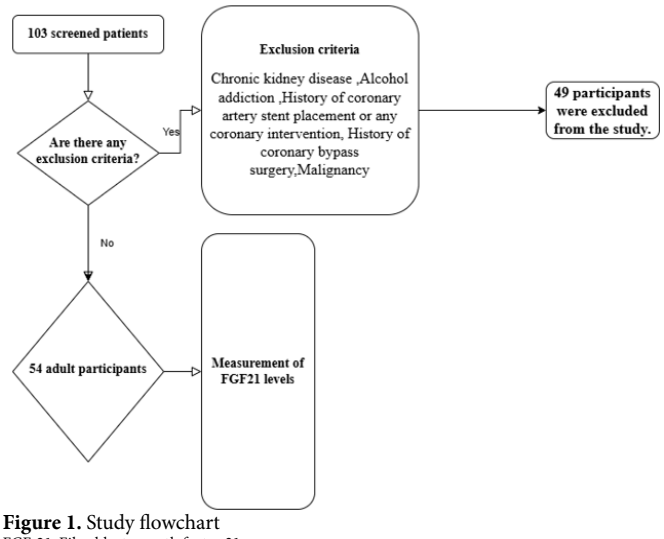

Figure 1. Study flowchart
FGF-21: Fibroblast growth factor 21

Statistical Analysis

Categorical data were presented as counts (with percentages within the group) and compared between groups using the Chi-squared test. The distribution of continuous data was assessed with histograms and Shapiro-Wilk's test in each group. Normally distributed data were expressed as mean±standard deviation, while non-normally distributed continuous data and ordinal data were reported as median (25^{th} percentile-75^{th} percentile). Spearman's correlation test was used to assess the relationships between Agatston calcium scores and FGF-21 values with all continuous data. Statistical analyses were performed with SPSS software (version 26.0, Chicago, IL, USA). A power analysis was conducted for the study, and it was determined that a minimum of 40 patients was required, with a statistical power of 80% and an alpha level of 0.05.

RESULTS

The demographics of the entire study population are summarized in **Table 1**. The mean age of the participants was 53.6±8.66 years. Among the population, 29 participants (53.7%) were female. Regarding comorbidities, 18 (33.3%) had diabetes mellitus, 23 (42.6%) had hyperlipidemia, and 17 (31.5%) had hypertension. These characteristics provide important context for understanding the health status and potential risk factors within the study population.

Table 1. Demographics and comorbidities of all population

Age, mean±SD	53.6±8.66
Female gender, n (%)	29 (53.7)
Diabetes mellitus, n (%)	18 (33.3)
Hyperlipidemia, n (%)	23 (42.6)
Hypertension, n (%)	17 (31.5)

SD: Standard deviation

In the overall study population, the median Agatston calcium score was 6 (IQR: 0–41) (Table 2). A statistically significant positive correlation was observed between FGF-21 levels and the Agatston calcium score (median FGF-21: 43.26 pg/ml, IQR: 35.29–59.02; p<0.05), suggesting a potential link between FGF-21 and subclinical coronary atherosclerosis. Additionally, the systemic immune-inflammatory index (SII) was found to be moderately elevated in the population (median: 534, IQR: 403–642), although no statistically significant correlation with calcium score was detected. Other hematological and biochemical parameters, including neutrophil, lymphocyte, and leukocyte counts; hemoglobin; platelet count; urea; creatinine; uric acid; and lipid profile, were within expected reference ranges for a general population with cardiovascular risk factors. These variables did not show statistically significant associations with coronary calcium score in the current analysis.

Table 2. Agatson calcium score and laboratory parameters of all population

Parameters	Median (IQR)
Agatson calcium score	6 (0-41)
FGF 21 (pg/ml)	43.26 (35.29-59.02)
Neutrophil (/µL)	4550 (3850-5190)
Lymphocyte (/µL)	2180 (1860-2720)
Leucocyte (/µL)	7245 (6270-9110)
Hemoglobin (g/dl)	14.2 (13.3-15.6)
Platelet (/µL)	270500 (222000-320000)
Systemic immune inflamatory index	534 (403-642)
Urea (mg/dl)	30 (26-34)
Uric acid (mg/dl)	5.1 (4.5-5.6)
Creatinine (mg/dl)	0.78 (0.66-0.91)
Total cholestrole (mg/dl)	204 (188-237)
Triglyceride (mg/dl)	171 (112-223)
HDL cholestrole (mg/dl)	42 (35-51)
LDL cholestrole (mg/dl)	124 (106-145)
VLDL cholestrole (mg/dl)	34 (22-45)
Non-HDL cholestrole (mg/dl)	161 (134-193)

IQR: Interquartile range, FGF-21: Fibroblast growth factor 21, HDL: High-density lipoprotein, LDL: Low-density lipoprotein, VLDL: Very low-density lipoprotein

As shown in Table 3, in the analysis of Agatston calcium scores and FGF-21 levels across various subgroups, no significant correlation was found between age and Agatston score (p=0.233), although a weak positive correlation was observed between age and FGF-21 levels (p=0.17). Similarly, no significant correlation was observed between gender and either Agatston score (p=0.339) or FGF-21 levels (p=0.931). A significant positive correlation was found between diabetes and Agatston score (p=0.006), with higher calcium scores observed in diabetic patients, while no significant correlation was found for FGF-21 levels (p=0.065). Additionally, a significant correlation was found between hyperlipidemia and Agatston score (p=0.024), with higher calcium scores in patients with hyperlipidemia, although no significant correlation was observed for FGF-21 levels (p=0.104). Finally, no significant correlations were found between hypertension and either Agatston score (p=0.437) or FGF-21 levels (p=0.202). These findings suggest that diabetes and hyperlipidemia are significantly associated with Agatston calcium scores, whereas FGF-21 levels show less significant associations with these factors.

Table 3. Comparison of Agatson calcium score and FGF21 levels between subgroups with Spearman's correlation test

	Agatson		FGF-21	
	Median (IQR)	p	Median (IQR)	p
Age		0.17		0.233
50 or younger (n=17)	1 (0-12)		37.5 (35.3-50)	
51 or older (n=37)	8 (0-78)		45.3 (36.9-60.9)	
Gender		0.339		0.931
Male (n=25)	10 (0-46)		41.5 (35.6-57.8)	
Female (n=29)	3 (0-25)		45 (35.3-59)	
Diabetes mellitus		0.006		0.065
No (n=36)	1 (0-12)		40 (34.7-51.2)	
Yes (n=18)	23 (3-86)		48.1 (39.7-68.7)	
Hyperlipemia		0.024		0.104
No (n=31)	1 (0-12)		37.5 (34.4-53.4)	
Yes (n=23)	23 (0-86)		46.2 (38.7-68.7)	
Hypertension		0.437		0.202
No (n=37)	5 (0-22)		40 (34.4-53.4)	
Yes (n=17)	7 (0-85)		46,9 (38.7-63.4)	

IQR: Interquartile range, FGF-21: Fibroblast growth factor 21

As shown in Table 4, Spearman's correlation test was performed to examine the relationships between Agatston calcium scores and FGF-21 levels with various clinical parameters. A significant positive correlation was observed between the Agatston calcium score and FGF-21 levels (r=0.725, p<0.001), indicating a strong association between these two variables. Additionally, age showed weak positive correlations with both Agatston calcium score (r=0.242, p=0.079) and FGF-21 levels (r=0.26, p=0.058), although neither of these correlations reached statistical significance.

Regarding other parameters, no significant correlations were found between Agatston calcium scores or FGF-21 levels and the following variables: neutrophils, lymphocytes, leucocytes, hemoglobin, platelets, SII, urea, uric acid, creatinine, total cholesterol, triglycerides, HDL cholesterol, LDL cholesterol, VLDL cholesterol, or non-HDL cholesterol (all p-values >0.05). This suggests that these clinical markers do not have a substantial relationship with Agatston calcium scores or FGF-21 levels in this study population.

A strong positive correlation was observed between FGF-21 levels and Agatston-based CAC scores (r=0.725, p<0.001). This relationship is visually illustrated in Figure 2, which presents the Spearman's correlation between the two parameters, highlighting their significant association.

Table 4. Spearman's correlation test of Agatston calcium score and FGF21 levels

	Agatson calcium score		FGF21	
	Correlation coefficient	p	Correlation coefficient	p
Age	0.242	0.079	0.26	0.058
Agatson calcium score	1	.	0.725	<0.001
FGF 21 (pg/ml)	0.725	<0.001	1	.
Neutrophil (/µL)	0.145	0.295	-0.061	0.66
Lymphocyte (/µL)	0.246	0.073	0.181	0.189
Leucocyte (/µL)	0.171	0.217	-0.021	0.88
Hemoglobin(g/dl)	0.173	0.21	0.001	0.992
Platelet (/µL)	-0.158	0.254	0.027	0.845
Systemic immune inflamatory index	-0.204	0.14	-0.251	0.068
Urea (mg/dl)	0.025	0.858	-0.004	0.98
Uric acid (mg/dl)	-0.052	0.706	0.064	0.648
Serum Creatin (mg/dl)	0.197	0.152	0.084	0.544
Total cholestrole (mg/dl)	0.011	0.939	0.097	0.483
Triglyceride (mg/dl)	0.197	0.153	0.227	0.098
HDL cholestrole (mg/dl)	-0.216	0.117	-0.207	0.133
LDL cholestrole (mg/dl)	-0.018	0.9	0.019	0.893
VLDL cholestrole (mg/dl)	0.197	0.153	0.232	0.092
Non-HDL cholestrole (mg/dl)	0.036	0.797	0.093	0.502

FGF-21: Fibroblast growth factor 21, HDL: High-density lipoprotein, LDL: Low-density lipoprotein, VLDL: Very low-density lipoprotein

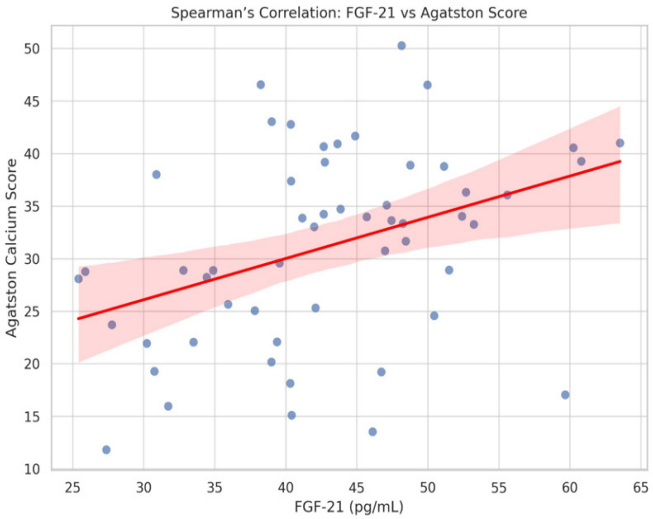

Figure 2. Spearman's correlation between FGF-21 and Agatston score
FGF-21: Fibroblast growth factor 21

DISCUSSION

In our study, the relationship between FGF-21 levels and the coronary calcium score based on the Agatston method was examined, and the potential of FGF-21 as a non-invasive biomarker for coronary calcium score was investigated. Our study revealed a strong positive correlation between FGF-21 levels and the Agatston-based coronary calcium score ($r=0.725$, $p<0.001$). This finding supports the hypothesis that FGF-21 could serve as a non-invasive biomarker indicative of subclinical atherosclerosis. While the coronary calcium score remains a valuable imaging-based risk stratification tool, the non-radiative and accessible nature of FGF-21 offers practical advantages, especially in settings where CT imaging is not feasible. FGF-21 plays a significant role in metabolic processes and may influence vascular calcification.[2]

Previous research has demonstrated the significant role of the Agatston-based coronary calcium score in identifying individuals at high risk of atherosclerosis.[25] Additionally, many cardiovascular disease guidelines emphasize the use of the Agatston-based coronary calcium score as a primary tool for predicting coronary artery disease risk.[26,27] However, the necessity of imaging methods for calculating the Agatston score limits its applicability in all healthcare centers. Imaging requirements, particularly CT scans, can lead to radiation exposure, which could be avoided by using non-invasive biomarkers like FGF-21.

Numerous studies in the literature have investigated the relationship between FGF-21 levels and cardiovascular disease prognosis. Early clinical studies have shown that elevated FGF-21 levels are associated with cardiovascular events and higher mortality.[28,29] However, the relationship between the Agatston-based coronary calcium score and FGF-21 has not been previously explored in the literature, and our study is the first to evaluate this relationship. Several in vitro studies have shown that FGF-21 can reduce endothelial dysfunction and atherosclerosis through various mechanisms.[30] In our study, a significant correlation was observed between the Agatston-based coronary calcium score, which is an indicator of endothelial dysfunction, and FGF-21 levels, due to the exclusion of participants with known coronary artery disease and coronary bypass surgery. This suggests that FGF-21 may play a role in the early stages of atherosclerosis development.[25] Many studies in the literature have explored how FGF-21 achieves this.

FGF-21 modulates key mechanisms of atherosclerosis by reducing foam cell formation, inhibiting endothelial apoptosis and pyroptosis, and suppressing vascular smooth muscle cell proliferation through multiple signaling pathways, including SIRT1, Fas, NLRP3 and NF-κB. It reduces the formation of foam cells derived from macrophages, decreases endothelial apoptosis by inhibiting the Fas signaling pathway, and reduces endothelial pyroptosis by inhibiting certain inflammatory pathways.[12-14] Furthermore, FGF-21 inhibits the migration and proliferation of vascular smooth muscle cells via the FGFR1-BALAK tyrosine kinase-NLRP3 inflammatory pathway.[19] FGF-21 also inhibits the transformation of macrophages into foam cells and the proliferation of vascular smooth muscle cells by stimulating adiponectin secretion.[20]

In addition to these effects, FGF-21 may influence atherosclerosis and coronary artery disease through metabolic pathways. Some studies have shown that FGF-21 increases insulin-independent glucose uptake and reduces serum triglyceride levels.[31] However, in our study, no correlation was found between FGF-21 levels and triglyceride levels. This discrepancy may be attributed to the fact that the triglyceride levels of participants in our study were within the normal range. This suggests that the effects of FGF-21 on metabolism may vary depending on individual characteristics and clinical conditions.

Recent studies have shown that certain diabetes medications, such as sodium/glucose cotransporter-2 inhibitors (SGLT2i), can increase serum FGF-21 levels.[32] Future studies should investigate the relationship between the Agatston-based

coronary calcium score and FGF-21 in patients treated with SGLT2 inhibitors. This may be particularly important for diabetic patients, as these drugs can affect both metabolic pathways and FGF-21 levels, potentially influencing the development of coronary artery disease.

FGF-21 derivatives have been shown to have positive effects on body weight, lipid profiles, and various metabolic conditions.[33-35] This could be due to the fact that the lipid profiles of participants with a diagnosis of hyperlipidemia in our study were well-controlled. In the future, controlled studies examining FGF-21 levels in patients with lipid profiles within normal reference ranges may help clarify the relationship between FGF-21 and lipid metabolism. In our study, while serum FGF-21 levels were significantly correlated with CAC scores, no significant association was observed between FGF-21 and traditional metabolic risk factors such as diabetes mellitus and hyperlipidemia. This finding suggests that FGF-21 may reflect coronary artery calcification independently of these conventional risk factors. It raises the possibility that FGF-21 is directly involved in or responds to the atherosclerotic process itself, rather than acting solely as a marker of metabolic disturbances. Further studies with larger sample sizes are warranted to better elucidate the underlying mechanisms of this association.

In our study, we also examined the relationship between the Agatston-based coronary calcium score and conditions such as diabetes and hyperlipidemia. The lack of a statistically significant association between FGF-21 levels and diabetes or dyslipidemia may stem from the relatively small sample size. Alternatively, these comorbidities may elevate FGF-21 levels via mechanisms involving endothelial dysfunction, independent of calcification severity. Furthermore, the study population was composed of asymptomatic individuals undergoing coronary CT solely for risk stratification, allowing the evaluation of FGF-21 in a relatively isolated cohort. One of the aims of our study was to prevent unnecessary testing in borderline cases before coronary CT angiography by considering FGF-21 levels. Future studies could focus on patients with coronary artery disease.

The use of FGF-21 as a non-invasive and easily applicable biomarker for coronary artery disease risk. FGF-21 could be used in the clinical setting to guide patient selection for CT imaging. Additionally, in patients with low FGF-21 levels, unnecessary imaging procedures may be avoided. We recommend further research on the relationship between FGF-21 and the Agatston-based coronary calcium score, including prognostic studies.

Limitations

This study has several limitations. Although a power analysis was conducted, the sample size remains relatively limited. This constraint particularly affected our ability to perform subgroup analyses based on comorbid conditions such as diabetes and hyperlipidemia, or across different calcium score ranges. Additionally, the study was conducted at a single center, which may limit the generalizability of the findings to populations with different demographic and clinical characteristics.

Due to its cross-sectional design, the study does not allow for evaluation of whether FGF-21 levels can predict future cardiovascular events. Moreover, the CAC scores were assessed by a single radiologist, introducing the possibility of observer bias. Another limitation concerns the use of medications that may influence FGF-21 levels, such as statins or SGLT2 inhibitors. These agents were not included in the analysis because complete, standardized, and reliable retrospective data on medication use were not available, and adherence to prescribed therapies could not be confirmed. Consequently, potential pharmacological interactions could not be assessed.

Finally, the findings of this study were not validated in an independent external cohort. Therefore, multicenter, prospective studies with larger sample sizes are warranted to confirm the generalizability and validity of these results.

CONCLUSION

This study demonstrated a significant and strong positive correlation between serum FGF-21 levels and Agatston-based CAC scores. These findings suggest that FGF-21 may serve as a practical, non-invasive biomarker capable of reflecting subclinical atherosclerosis. Particularly in clinical settings where coronary CT angiography is not readily available due to limitations such as radiation exposure and cost, the use of FGF-21 as a preliminary screening tool could enhance clinical decision-making.

Notably, no significant associations were observed between FGF-21 levels and conventional metabolic risk factors such as diabetes mellitus and hyperlipidemia. This may indicate that FGF-21 functions as a cardiovascular risk indicator independently of these classical metabolic conditions.

The study population consisted of asymptomatic individuals undergoing coronary CT angiography for risk assessment rather than diagnostic purposes. This provided a unique opportunity to investigate the relationship between FGF-21 levels and early vascular changes. Our findings suggest that FGF-21 may be associated not only with metabolic pathways, but also with direct atherosclerotic mechanisms such as endothelial dysfunction and vascular wall inflammation.

In conclusion, FGF-21 appears to hold potential as a non-invasive screening marker for individuals at risk of coronary artery disease who do not yet present with clinical symptoms. Further large-scale, multicenter, prospective studies are warranted to clarify the diagnostic and prognostic value of this biomarker. Moreover, future research exploring FGF-21 levels across different patient subgroups and in the context of various pharmacological treatments would provide valuable insights for the field.

ETHICAL DECLARATIONS

Ethics Committee Approval

All procedures were approved by the Ethics Committee of Ankara Bilkent City Hospital (Date: 29.05.2024, Decision No: TABED 2/209/2024).

Informed Consent

All patients signed and free and informed consent form.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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Original Article

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Essential amino acids levels in individuals that attempted suicide

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ABSTRACT

Aims: In our study, plasma essential amino acid levels were analyzed in patients with depressed mood by comparing patients who applied to the emergency department after a suicide attempt with the control group. It was hypothesized that certain essential amino acid levels would be lower in individuals who attempted suicide compared to the control group.

Methods: Plasma/serum samples obtained from the control group and the patient group were removed from -80°C where they were stored and thawed, and all amino acid levels in plasma/serum were measured with Q-TOF LC/MS. Kolmogorov-Simirnov, Man-Whitney U test and Chi-square test were used in the evaluation of the data and the error level was taken as 0.05. In this study, $\alpha=0.05$; When $\beta=0.10$ and $(1-\beta)=0.90$, it was decided to include 35 individuals in each group and the power of the test was found to be $p=0.90744$.

Results: When the essential amino acids were examined in general, in the comparison made between the patient and control groups, methionine, leucine, isoleucine, valine, lysine, threonine, phenylalanine and tryptophan amino acids were found to be significantly low in the patient group ($p<0.05$). However, no statistically significant difference was found in the comparison made between the two groups for histidine amino acid ($p=0.405$; $p>0.05$).

Conclusion: In our study, it was concluded that suicidal behavior was more common in female gender and people with low socioeconomic status. Among the essential amino acids taken through nutrition, a significant decrease was found in this study, especially in amino acids that are precursors of important neurotransmitters (serotonin, noradrenaline, dopamine, etc.) that affect mood. At the same time, a significant decrease was found in amino acids that affect the skeletal-muscular system and play an active role in energy metabolism.

Keywords: Emergency medicine, food quality, amino acids, suicidal behavior

INTRODUCTION

Depression has become an important public health problem both individually and socially. In patients applying to health institutions, self-blame, worthlessness, hopelessness, and recurrent suicidal thoughts are at the forefront. Especially since physiological functionality is also impaired, loss of appetite, weight loss, sleep and concentration disorders, fatigue, psychomotor agitation, and retardation are observed in this patient population. Depression is considered a chronic process, and when left untreated, the number of attacks and destruction increases.[1]

Suicidal behavior has been one of the leading preventable causes of premature deaths that threaten life in recent years. Since emergency services are the first place patients apply and receive intervention after a suicide attempt, research on this population is gaining great importance in this field.

Suicidal behavior is the transformation of a self-harming thought, which is closely related to the concept of depression and impulsivity, into active action, which can be fatal. The psychological and socioeconomic aspects of suicidal behavior have been examined in many studies, but its neurobiological aspect has not been sufficiently elucidated.[2] Approximately 45.000 people in the United States[3] and more than 800.000 people worldwide die by suicide each year.[4] Diet plays a significant role in a person's mood and behavior. Amino acids are key precursors in the synthesis of neurotransmitters, hormones, and enzymes that play a role in the continuation of all vital functions in humans. There are 20 basic standard amino acids in nature, and these amino acids play a fundamental role in the control and regulation of both the physical and biological functions of the human body.[5,6] Amino acids, which are effective in all metabolic

processes in the body, are divided into two groups in terms of their biological importance: essential (exogenous) and non-essential (endogenous). Essential amino acids cannot be synthesized in the body; they must be taken from outside with food. Non-essential amino acids, which are necessary for the continuation of vital functions, are synthesized by the body. Essential amino acids; methionine, tryptophan, lysine, leucine, isoleucine, valine, threonine, phenylalanine and histidine. Methionine restriction is important in delaying the onset of neurodegenerative diseases and increasing body resistance to stress factors.[7] Tryptophan participates in the structure of serotonin and melatonin. Serotonin deficiency, known as the happiness hormone in humans, causes depressive and tired moods. The precursor amino acid serotonin, tryptophan, is also very important in this context. Lysine is one of the essential amino acids for the skeletal-muscular system and plays an important role in the production of muscle proteins, especially in sports injuries and post-surgery periods. Leucine acts as a stimulating signal in the body, especially during the developmental stage of babies, and accelerates the anabolic process, especially in muscle protein synthesis. It is also the most effective amino acid in delivering glutamate, an important excitatory neurotransmitter in the brain, to neurons. It significantly improves cerebellar symptoms.[8] Isoleucine; It plays a role in all physiological functions in the body such as growth, immunity, protein metabolism, fatty acid metabolism and glucose transport. Valine also plays an active role in cell metabolism (especially transamination, oxidative decarboxylation etc.).[9] Valine is oxidized in brain tissue and forms glutamine from glutamate. Thus, the brain protects itself against ammonia thanks to its amine group. Threonine is extremely important in protecting intestinal mucosal integrity, barrier function and also physiology.[10] Since histidine is used as a metabolite in histamine biosynthesis, when its deficiency occurs, anxiety, fatigue and depression symptoms are observed in humans since histamine release is reduced.[11] Leucine-histidine dipeptide reduces depression symptoms by suppressing primary microglia activation.[12]

METHODS

Each stage of the study was carried out in accordance with ethical rules. Prior to implementation, written permission was obtained from the Clinical Researches Ethics Committee of Sivas Cumhuriyet University (Date: 03.12.2019, Decision No: 2019-12/01). After the informed consent forms were read and informed to the patients and healthy volunteers or their legal heirs, a written consent form was signed. Afterwards, blood samples were taken from these volunteers and they were included in the study. The study is an article produced from a thesis and was completed in accordance with the Helsinki Declaration.

In the study, 35 people who applied to Sivas Cumhuriyet University Faculty of Medicine Emergency Medicine Department after a suicide attempt between July 2020 and December 2020 were evaluated as a patient group after detailed anamnesis and physical examination. Among the patients who applied to the emergency service between these dates, those who were suitable were included in the study. The control group was also selected from a population similar to the patient group in terms of age and gender. The study was based entirely on the principle of volunteerism within the scope of the informed consent form for both groups.

Patients with acute or chronic diseases (such as diabetes mellitus, hypertension, chronic renal failure, heart failure, liver pathologies), patients with autoimmune diseases, patients with infections, and those with eating habits different from normal were excluded from this study.

Approximately 10 ml of venous blood was taken from the patient and control groups and transferred to an EDTA and empty silicone tube. These blood samples were centrifuged at +4°C 4000 rpm for 5 minutes, and the plasma/serum obtained was portioned into 2 separate Eppendorf tubes. The blood samples were stored at -80°C until the relevant parameters were studied.

The plasma/serum samples obtained from the patient and healthy control groups were removed from the -80°C storage and thawed, and all amino acid levels in the plasma/serum were measured by the relevant laboratory with a Q-TOF LC/MS device. The data obtained from our study were loaded into the SPSS (ver:22.0) program and Kolmogorov-Simirnov, the significance test of the difference between two means, Man-Whitney U test, Chi-square test were used in the evaluation of the data and the error level was taken as 0.05. In this study, when $\alpha=0.05$; $\beta=0.10$ and $(1-\beta)=0.90$, it was decided to include 35 individuals in each group and the power of the test was found to be $p=0.90744$.

RESULTS

The mean age of the 35 patients evaluated in the study was 30.17±11.65 years and the mean age of the 35 individuals in the control group was 30.97±9.46 years ($p=0.15$; $p>0.05$).

22 (62.9%) of the individuals in the patient group were female and 13 (37.1%) were male; 22 (62.9%) of the individuals in the control group were female and 13 (37.1%) were male ($p=1$; $p>0.05$).

When the distribution of the groups according to educational status was evaluated; 17 (48.6%) of the individuals in the patient group were primary school and high school graduates and 18 (51.4%) were university and postgraduate graduates. 14 (40%) of the individuals in the control group were primary school and high school graduates; 21 (60%) are university and graduate graduates. The difference between the groups in terms of educational status is not statistically significant ($p=0.43$; $p>0.05$). While 14 (40%) of the patient group evaluated in the study had a psychiatric history, 21 (60%) did not have a psychiatric history. In the control group, 3 (5.7%) had a psychiatric history, and 32 (94.3%) did not have a psychiatric history. The current difference between the groups was found to be statistically significant ($p=0.01$; $p<0.05$) (**Table 1**).

When the suicide methods of the individuals in the group of 35 patients who applied to the emergency room after a suicide attempt were examined; 32 of the patients (91.4%) applied after taking medication, 1 (2.9%) jumped from a height, and 2 (5.7%) self-harmed with a sharp object.

When the types of medications taken by the individuals in the patient group who committed suicide by taking medication were evaluated; 11 (31.4%) of the patients committed suicide by antidepressants, 7 (20%) by analgesics and antibiotics,

Table 1. Comparison of groups in terms of gender, age, education status and psychiatric history

	Patient group n (%)	Control group n (%)	Ki kare test
Gender			p=1
Female	22 (62.9)	13 (37.1)	
Male	22 (62.9)	13 (37.1)	
Average age	30.17	30.97	p=0.15
Education status			p=0.43
Primary school+high school	17 (48.6)	14 (40)	
University+postgraduate	18 (51.4)	21 (60)	
Psychiatric history			p=0.00*
Yes	14 (40)	3 (5.7)	
None	21 (60)	32 (94.3)	

* p<0.05

6 (17.1%) by nonsteroidal anti-inflammatory drugs, and 3 (8.6%) by antiepileptic drugs.

When the essential amino acids were examined in general, the amino acids methionine, leucine, isoleucine, valine, lysine, threonine, phenylalanine and tryptophan were found to be significantly lower in the patient group in the comparison made between the patient and control groups (p<0.05). However, no statistically significant difference was found in the comparison between the two groups for histidine amino acid (p=0.405; p>0.05) (**Table 2**).

Table 2. Comparison of essential amino acids between groups

Aminoacids	Patient mean±SD	Control mean±SD	t test (p value)
Methionine	25±6	30.9±6.6	<0.001*
Leucine	101.6±25.8	125.2±23.3	<0.001*
Isoleucine	73.4±18.7	92.8±20.3	<0.001*
Valine	171.6±41.9	205.8±38.04	0.001*
Lysine	150.4±29.5	169.4±31.6	0.011*
Threonine	115.9±37.3	140.8±34.4	0.005*
Phenylalanine	50.4±13.6	58.9±32.5	0.008*
Histidine	75.7±7.09	77.4±9.33	0.405
Tryptophan	45.1±10.4	59.2±9.7	<0.001*

*p<0.05, SD: Standard deviation

DISCUSSION

When we examine the data obtained in the study; as in many studies examining the suicidal behavior of the patient population applying to the emergency room after a suicide attempt, it was found to be higher in women (female:male ratio 1.69:1). Women have higher rates of suicidal ideation and behavior than men.[13-16]

When the sociodemographic and socioeconomic characteristics of the patients are considered; the results are similar to different studies.[17,18] Suicidal behavior was found to be higher in people with low social status. In another study examining the effect of socioeconomic levels on suicidal behavior, unemployment stood out as a situation that increases the risk of suicide. The probability of suicide attempt increases as the duration of unemployment increases.[19]

Psychiatric history was detected in 40% of the patients applying after a suicide attempt. There are different clinical studies showing a significant link between suicidal behavior and psychiatric disorders, and in this context, our study overlaps with many clinical studies.[20,21] Psychiatric disorders in particular have been accepted as an important risk factor for suicide attempts.[15,22]

When the suicide methods in our study were evaluated, it was seen that 91.4% of the patients applied with drug intoxication. When the drugs taken by the patients applied with drug intoxication were evaluated, they most frequently preferred antidepressants that they used for treatment purposes. This was followed by self-harm with a sharp object at 5.7% and jumping from a height at 2.9%. The rates determined regarding the suicide method were not subject to discrimination for women and men in our study. When different studies were evaluated, it was determined that men usually died by suicide by hanging, carbon monoxide poisoning, and gunshot wounds; while it was emphasized that women mostly exhibited suicidal behavior by taking drugs.[13,15,16,23]

In our study, all essential amino acids (leucine, isoleucine, valine, methionine, threonine, lysine, phenylalanine, and tryptophan), except for histidine, were found to be significantly lower in the patient group compared to the control group (**Table 2**). As it is known, essential amino acids are essential amino acids that must be taken externally. Low levels of these amino acids in the patient group showed that nutrition and protein intake were significantly reduced in patients with depressive mood. Essential amino acids (leucine, isoleucine, valine) that regulate the skeletal-muscular system and energy metabolism were significantly lower in the patient group (p=0.001; p<0.05).When the amino acids that are examined in relation to depression and important clinical studies in the literature are considered, methionine facilitates the synthesis of important neurotransmitters such as serotonin, norepinephrine, and dopamine, which affect the mood in the body and give people a sense of happiness and vitality.[24-26] Therefore, the low levels of methionine in the suicidal patient group with depressed mood in our study was an important result (p<0.001; p<0.05). Since phenylalanine, one of the essential amino acids, plays a role in the synthesis of norepinephrine, some forms are used in the treatment of depression. In its deficiency; anorexia, loss of appetite, weakness, and depression can be seen.[27] Depressive and tired moods are also seen in the deficiency of tryptophan, which is included in the structure of serotonin and melatonin.[28] Almost all physical and psychological stress factors affect serotonin levels in the human body. Tryptophan amino acid, which directly affects serotonin levels, was also found to be significantly low in the patient group in our study (p<0.001; p<0.05).

In our study, we determined the relationship between suicidal behavior and essential amino acid amount analyses in plasma by considering the sociodemographic characteristics of the patients. We evaluated the precursor amino acids responsible for every stage of both physiological and psychological processes in humans.

The frequency of suicidal behavior has started to increase in recent years. Since emergency services are the first places

to apply after suicide attempts, evaluations and statistical analyses conducted in emergency services in particular should have clinical importance in the literature.

CONCLUSION

There are many studies examining the relationship between factors such as diet, socioeconomic level, psychiatric history, demographic characteristics, etc. and suicide attempts. There are also studies examining the relationship between suicidal behavior and depression and certain amino acids taken due to nutrition. However, our study is the only comprehensive study based on measuring essential amino acid levels in the body along with socioeconomic and demographic characteristics, as it was conducted in the emergency department during the acute period. Despite this, being a single-center study has a restrictive effect on generalizability. Based on our study results, we believe that suicide attempts can be prevented by increasing neurobiological and mental activity along with regular protein intake, nutrition, and exercise. We also believe that studies with high participation will yield results that support our study.

ETHICAL DECLARATIONS

Ethics Committee Approval

Prior to implementation, written permission was obtained from the Clinical Researches Ethics Committee of Sivas Cumhuriyet University (Date: 03.12.2019, Decision No: 2019-12/01).

Informed Consent

All patients signed and free and informed consent form.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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Case Report

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Wernicke-Korsakoff syndrome in the emergency department: a case report

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ABSTRACT

Wernicke-Korsakoff syndrome (WKS) is a severe, potentially irreversible neuropsychiatric illness frequently linked with alcohol use disorder and thiamine (vitamin B1) deficiency. The acute phase, Wernicke encephalopathy (WE), presents with confusion, ataxia, and oculomotor dysfunction. The triad of symptoms may not always be present, however, and diagnosis is therefore troublesome. In this case, a chronically alcoholic and malnourished patient came with a change in mental status, which led to the diagnosis of WE and was initiated on high-dose thiamine treatment. Prompt treatment led to quick clinical recovery. Diagnosis of WE in the emergency department and prompt treatment as a component of multidisciplinary care is paramount to avoid long-term neurological impairment.

Keywords: Confusion, disorientation, emergency department, thiamine, Wernicke encephalopathy

INTRODUCTION

Wernicke–Korsakoff syndrome (WKS) is a severe neuropsychiatric disorder resulting from a lack of thiamine (vitamin B1) and frequently occurring alongside alcohol use disorder. The first phase of the syndrome, Wernicke encephalopathy (WE), is presumably reversible and presents with the classic triad of confusion, ataxia, and oculomotor dysfunction. It must, however, be remembered that the triad of symptoms may not occur concurrently in all individuals, thereby rendering the diagnosis difficult.[1-3]

Although WE is most commonly associated with alcohol-related brain damage, it may also result from many other causes of thiamine deficiency, including those due to malnutrition, gastrointestinal malabsorption, post-bariatric surgery syndrome, and prolonged fasting.[1,3,4] Diagnosis is usually based on a clinical evaluation, which requires a high degree of clinical suspicion.[1,2,5]

The initiation of parenteral thiamine therapy at high doses prior to confirmation of the diagnosis can potentially result in the rapid resolution of neurological symptoms. Nevertheless, with delayed treatment and diagnosis, there is a much greater risk of developing long-term cognitive dysfunction and increased mortality.[6] It is thus extremely critical to always include Wernicke's encephalopathy in the differential diagnosis of patients presenting in emergency departments, particularly those with preceding histories of alcohol use, malnutrition, or susceptibility to malabsorption. Treatment should be initiated immediately if two or more of the following features are present: nutritional deficiencies, ocular findings, cerebellar abnormalities, and changes in mental status.[7]

CASE

A 40-year-old male patient was brought to the emergency department by family members, who reported that he had experienced abnormal eye movements, severe numbness, lethargy, behavioural changes and disorientation over the previous few days. He was a chronic alcoholic who had attempted to abstain from alcohol for the previous week. During this period, he had also reduced his oral intake and stopped taking antianxiety medications. He had also stopped taking vitamin B supplements, and his diet had deteriorated. His family reported that he had not consumed food for the past two days, could not recognise his environment, and was unable to communicate his thoughts coherently.

On physical examination, the patient was somnolent and was only able to communicate minimally with those around him. His spontaneous speech was mostly incomprehensible, and he could not answer questions appropriately. He was unable to identify his relatives, describe his environment, or give the date, suggesting impairment of orientation to place,

time, and person. There were no motor deficits or noticeable articulatory impairment. He had a stable gait and normal extremity movement. Pupils were isocoric, and light reflexes were normal. Vital signs were stable (temperature: 36.7°C; blood pressure: 124/78 mmHg; pulse: 88 bpm; SpO_2: 97%).

Laboratory examinations revealed normal electrolyte, glucose, liver, and kidney function levels. Complete blood count results showed no signs of infection. Cranial computed tomography and magnetic resonance imaging scans did not reveal any acute pathologies. Infection, metabolic disorders, cerebrovascular accidents, and head injury were excluded as differential diagnoses based on the clinical and laboratory findings.

The evaluation revealed the patient's malnutrition, long-term alcoholism, thiamine deficiency, and progressive cognitive disorientation. A provisional diagnosis of WE was established, and the patient was started on high-dose parenteral thiamine replacement (500 mg intravenous administration, three times daily). Electrolyte replenishment and fluid resuscitation were also initiated as adjunct therapy. The patient's neurological status, level of consciousness, and response to intravenous therapy were closely monitored by the nursing team.

Six to eight hours after thiamine treatment began, there was a remarkable improvement in the patient's level of consciousness. Their orientation to place and time showed partial recovery, and they were able to communicate more effectively with their environment and recognise their relatives. On the following day, further improvement in mental status was observed, and orientation was significantly enhanced. The patient was subsequently admitted to the neurology ward for ongoing assessment and long-term supportive therapy.

DISCUSSION

We are referring to WKS, an acute clinical syndrome that, if not diagnosed and treated early, can result in irreversible neurological damage. Although it is usually characterised by the classical triad of confusion, ataxia, and oculomotor dysfunction, the absence of these features in some patients may lead to delayed diagnosis.[1,3,8] Thus, it is of paramount importance to maintain a high index of clinical suspicion, particularly in the emergency setting, to establish an early diagnosis.

Effective communication and division of labour among a multidisciplinary team are key to patient management in individuals presenting to emergency departments with suspected WE. In the present case, key nursing interventions included monitoring levels of consciousness using the Glasgow Coma Scale, repeated orientation and vital sign checks, observation for possible adverse reactions during intravenous thiamine infusion, and maintenance of fluid and electrolyte balance as dictated by laboratory findings. These interventions were essential to ensure patient safety and achieve clinical stabilisation.[9]

In the described case, acute alterations in consciousness and disturbances in orientation in patients with reduced oral intake, cessation of vitamin supplementation, and alcohol withdrawal must be included in the broad differential diagnosis. Following the exclusion of hypoglycaemia, electrolyte imbalance, sepsis, hepatic encephalopathy, stroke, and other toxic-metabolic causes, WE should be considered in the differential diagnosis of individuals with a history of malnutrition and thiamine deficiency, even in the absence of the classic triad.[8,10,11]

There is no definitive laboratory test for WE; thus, the diagnosis is primarily based on clinical presentation and associated risk factors. Magnetic resonance imaging (MRI) may support the diagnosis, most commonly revealing symmetrical signal enhancement in the thalamus, mammillary bodies, and periventricular regions. These imaging abnormalities, however, are not always present and typically become apparent only in more severe cases.[3,12] Hence, in the presence of strong clinical suspicion, it is recommended that high-dose parenteral thiamine therapy be initiated immediately, without awaiting confirmatory diagnosis.[2]

CONCLUSION

This case illustrates that WE is a significant clinical condition that is rarely diagnosed in emergency department practice, yet can lead to permanent neurological impairment if diagnosis is delayed. Diagnosis requires a systematic clinical assessment and a high index of suspicion, as delays are associated with worsening cognitive function and an increased risk of mortality.

Early treatment with high-dose parenteral thiamine can result in considerable clinical improvement in carefully selected patients within a limited time frame. Accordingly, patients with a history of alcohol use or risk factors such as malnutrition or malabsorption who present with confusion, memory loss, and disorientation should be thoroughly assessed for WE. Enhancing clinical suspicion may prevent long-term neurological damage through effective and inexpensive treatment.

ETHICAL DECLARATIONS

Informed Consent
The patient signed and free and informed consent form.

Referee Evaluation Process
Externally peer-reviewed.

Conflict of Interest Statement
The authors declare no conflict of interest.

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All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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Case Report

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Iatrogenic air embolism following contrast injection during CT pulmonary angiography: a rare but serious complication

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ABSTRACT

Air embolism is a rare but potentially life-threatening clinical condition resulting from the entry of air into the vascular system. Although it most commonly occurs following surgical or invasive procedures or trauma, it can also arise during imaging procedures involving contrast media administration. This report presents a case of a 73-year-old female patient who developed intravascular air embolism during thoracic CT angiography following intravenous contrast injection. The patient was successfully managed with oxygen therapy and conservative monitoring.

Keywords: Iatrogenic complications, air embolism, contrast injection

INTRODUCTION

Vascular air embolism is a serious clinical condition caused by air bubbles obstructing the arterial or venous circulation. Although iatrogenic air embolism is rare, it carries a high risk of morbidity and mortality, requiring rapid diagnosis and treatment.[1,2] It typically occurs after surgical interventions, intravascular catheterizations, hemodialysis, or trauma. Air embolism during contrast injection in imaging procedures is an extremely rare event.[3] This case aims to draw attention to this uncommon complication by presenting an iatrogenic air embolism that developed during contrast administration in thoracic computed tomography (CT) angiography.

CASE

A 73-year-old woman initially presented to her family physician with complaints of chest pain. Due to the persistence of symptoms and the need for further evaluation, she was referred to the emergency department. Her past medical history included diabetes mellitus, hypertension, and coronary artery disease, for which she was on regular medication.

On examination at the emergency department, her vital signs were as follows: blood pressure 110/60 mmHg, heart rate 90 bpm, oxygen saturation 91%, body temperature 36.8°C, and blood glucose level 150 mg/dl. She was alert, cooperative, and oriented, with no neurological deficits. Systemic examination was unremarkable. The chest pain was nonspecific and persistent. Electrocardiography revealed no abnormalities, and cardiac troponin levels were within normal limits.

Given the ongoing chest pain and borderline oxygen saturation, pulmonary thromboembolism was suspected, and thoracic CT angiography was ordered. For thoracic CT angiography, a 22-gauge (G) intravenous catheter was placed in the patient's left antecubital vein. A total of 180 ml of iodinated contrast material was administered. During the contrast injection at the rate of 4 ml/s, the patient developed sudden-onset back pain. Her heart rate increased to 120 bpm, oxygen saturation dropped to 88%, and blood pressure decreased to 95/55 mmHg. CT angiography revealed intravascular air densities in the right ventricle and pulmonary trunk (**Figure 1**).

The findings were attributed to air embolism likely introduced during contrast injection. The patient had no recent history of surgery or invasive intervention. She was admitted to the pulmonary ward and managed conservatively in the left lateral decubitus position with 10 L/min oxygen therapy. A follow-up thoracic CT performed on day 3 demonstrated complete resolution of the air embolism (**Figure 2**). The patient's clinical course remained stable, and she was discharged after her symptoms resolved.

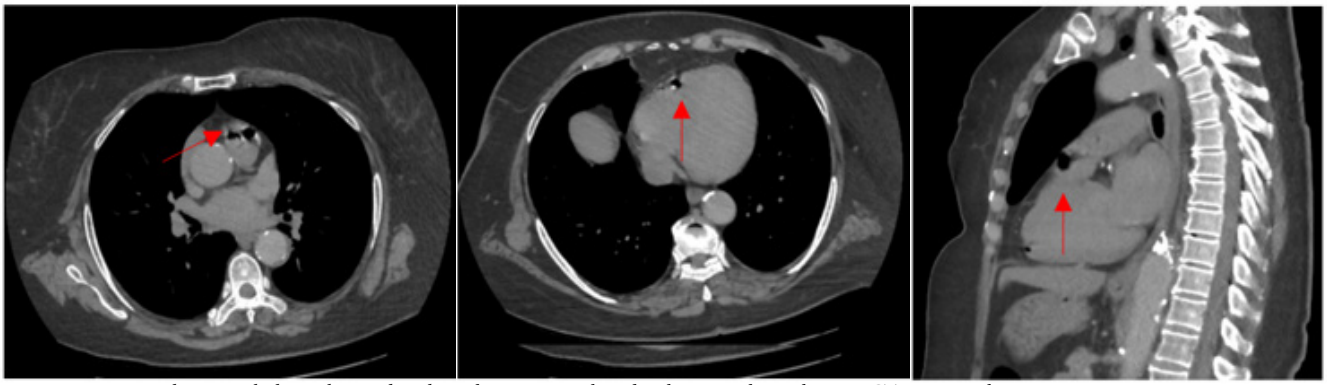

Figure 1. Intravascular air embolism observed in the pulmonary trunk and right ventricle on thoracic CT angiography
CT: Computed tomography

Figure 2. Resolution of intravascular air embolism in the pulmonary trunk and right ventricle on follow-up thoracic CT
CT: Computed tomography

DISCUSSION

Air embolism can occur due to factors such as direct communication between the vascular system and an air source, a favorable pressure gradient, and the patient's positioning. The risk is particularly high during surgeries like neurosurgical and otorhinolaryngological procedures, where elevated positions and low venous pressures facilitate air entry. Other contributing factors include hypovolemia, central venous catheterization, and mechanical ventilation.[4,5] Modern high-pressure injectors are generally equipped with air-sensing systems that can effectively warn or stop the injection when air is detected within the tubing, thereby reducing the risk of air entry into the patient. Nevertheless, air introduced during external tube connections may not be adequately eliminated by conventional saline test injections. Furthermore, the injection process is difficult to monitor in real time by technicians, nurses, or patients, making it challenging to detect the inadvertent entry of air bubbles during contrast administration.[6]

Air embolism most frequently involves the venous system and presents with pulmonary symptoms. Arterial embolism is rarer but can lead to severe outcomes.[4,7] In this case, the embolism developed due to contrast injection during CT imaging, which is an uncommon cause. In patients receiving high-flow contrast injections, failure to adequately eliminate air from injector systems can result in such complications.[3]

Air embolism should be suspected in patients who suddenly develop respiratory distress during procedures known to carry risk, such as IV catheter placement. Similarly, previous case reports of air embolism have also noted that patients symptoms during injection were non-specific.[8] Symptoms vary based on embolus size; while small emboli may be asymptomatic, larger ones can cause dyspnea, chest pain, cough, dizziness, and more. Common physical signs include tachycardia, tachypnea, and hypotension, as observed in our case.[9]

ECG in air embolism often shows sinus tachycardia. In venous embolism, signs of right heart strain such as peaked P waves, right bundle branch block, and right axis deviation may be seen.[4] In our patient, only sinus tachycardia was noted, without any specific ECG changes.

Diagnosis relies on imaging. Chest X-rays may show hyperlucency, pulmonary edema, or focal oligemia. CT can reveal air in the main pulmonary arteries, right heart chambers, or veins, although findings are often nonspecific.[10] No single imaging modality is sufficiently specific; therefore, clinical suspicion—especially in the presence of risk factors is key to diagnosis and management.[5]

Treatment typically involves high-flow oxygen and positioning the patient in the left lateral decubitus position. Positioning the patient in the left lateral decubitus and Trendelenburg position, known as Durant's maneuver, helps to relieve right ventricular outflow tract obstruction by promoting the migration and trapping of air in the apex of the right ventricle.[11] Hyperbaric oxygen therapy may be used when available.[12] Although hyperbaric oxygen therapy is not first-line treatment, it should be implemented if there is concern for paradoxical embolism and may also be a useful adjunct in severe cases.[1] In our case, diagnosis was made via CT, and the patient was successfully managed with conservative measures including oxygen therapy and positioning.

CONCLUSION

Although air embolism resulting from contrast injection is rare, it is a potentially serious complication. This case highlights that even routine imaging procedures may carry unforeseen risks, emphasizing the importance of meticulous technique and appropriate patient monitoring. Preventive measures during intravenous contrast administration, along with early diagnosis and management, are critical to patient outcomes. Prompt evaluation, high-flow oxygen therapy, and correct positioning can prevent severe complications. This case aims to raise awareness among clinicians regarding the importance of recognizing and managing rare yet life-threatening events such as air embolism.

ETHICAL DECLARATIONS

Informed Consent

The patient signed and free and informed consent form.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

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Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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