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Original Research

Effects of Atrioventricular Blocks in Acute Coronary Syndrome: Long-Term Follow-Up

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Abstract

Objectives: Arrhythmias are the common, potentially lethal, and treatable complication of acute coronary syndrome (ACS). Arrhythmic findings of ischemic cardiac events are well-known, but long-term results have not been scrutinized. In the study, we aimed to analyze the long-term findings of the atrioventricular block (AVB) in ACS patients.

Methods: This is a single-center and retrospective study of patients admitted with ACS and AVB. The primary endpoint has combined the outcome of major adverse cardiovascular events and mortality.

Results: Seventy-six (89.4%) patients had 3rd-degree AVB. Fifty (58.8%) patients are needed for temporary ventricular pacing and 4 (4.7%) for a permanent pacemaker. Although no cardiac death occurred during the 5-year follow-up period, the in-hospital mortality ratio was 30.6%. Patients with older age and lower systolic blood pressure (SBP) levels had higher mortality rates (respectively, odds ratio [OR] 1.088, [p=0.003], OR 0.912, [p<0.001]). Even in ST-segment elevation myocardial infarction and complete AVB subgroup analyses, mortality rates were associated with SBP and age (respectively, OR: 0.917, [p<0.001], OR: 1.107 [p=0.002]), (respectively, OR: 0.917 [p<0.001], OR: 1.087 [p=0.004]).

Conclusion: The study results are associated with a better long-term overall prognosis in patients with ACS with AVB, but lower SBP and older in-hospital follow-up are associated with poor prognosis.

Keywords: Acute coronary syndrome, Arrhythmia, Atrioventricular conduction block, AV block, Myocardial ischemia

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Acute coronary syndrome (ACS) represents clinically by unstable angina pectoris, non-ST-segment elevation myocardial infarction (NSTEMI), or STEMI. It is related to life-threatening complications.[1] Arrhythmias are common, potentially lethal, and treatable complications of ACS. Such arrhythmias are usually transient and typically resolve within 24 h. However, it is vital to recognize and initiate necessary treatment early as they can progress to irreversible and lethal disturbances.[2]

The conduction system is concerned with the blood supply. The right coronary artery (RCA) and left circumflex coronary artery (Cx) supply the sinoatrial node. Moreover, in most cases, the atrioventricular node is supplied by RCA.[3,4] Therefore, atrioventricular block (AVB) is more frequent in inferior STEMI, which is usually related to RCA occlusion. Ischemia of the conduction system can cause bradyarrhythmias.[5] Even after ACS, necrotic changes in the sinoatrial node can cause sinus arrest.[6]

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Sinus bradycardia occurs in 15–25% of patients with ACS. Patients with ACS associated persistent or hemodynamic instability bradyarrhythmias warrant consideration of temporary ventricular pacing (TVP).[7-9] A permanent pacemaker is not typically necessary for bradyarrhythmias following ACS because bradyarrhythmias are transient in most cases.[8] Several days of the observation period were suitable for a permanent pacemaker decision.

AVB associated with ACS is frequent, numerous in types, and associated with poor prognosis.[10,11] The most significant AVB after ACS is high-degree AVB (2nd-degree Type 2 and 3rd-degree) and intraventricular conduction defects.[12] In studies, the complete AVB (CAVB) incidence with inferior STEMI was 7.3–13%[13-15] and with anterior STEMI was 3.6–4.9%.[13,16] Studies have shown that STEMI patients with conduction disorders have a poor in-hospital prognosis.[13,14] However, the long-term impact of conduction abnormalities among ACS patients is unclear.

Despite numerous publications showing rhythm disturbances caused by ACS, none evaluated the long-term features of ACS complicated by AVB. To address these limitations, we performed a cohort and retrospective study to present our long-term follow-up features of ACS patients.

Methods

Study Design and Population

The mean follow-up period was 33.1±17.5 months (3–62). Eighty-five subjects had ACS (unstable angina pectoris, NSTEMI, or STEMI) with AVB between May 2015 and August 2020 (Table 1). The study population was drawn from the archive of the Hospital Information Management Database. Hospital records, medical files, clinical and laboratory findings, and hospital discharge records consist of information on diagnosing, the reason for admission, and discharge findings are evaluated. Patients were excluded from the study if any data were missing. We have reviewed the records of 90 patients. Five patients were excluded due to insufficient evidence of outcome events. Mortality was evaluated during hospitalization and at a 5-year follow-up. The follow-up evaluation was performed with telephonic contact and with the hospital data to check the occurrence of morbidity or mortality. The primary outcome was a composite of death from cardiac causes, MI, or revascularization. Death was considered a cardiac cause unless a noncardiac cause could be established. Revascularization was defined as any type of percutaneous coronary intervention (PCI) or surgical revascularization procedure. Furthermore, outcome variables studied were heart failure, cardiac arrest, cerebrovascular event, ventricular arrhythmias, stroke, ACS, a requirement for an implantable-cardioverter-defibrillator (ICD), and a temporary or permanent pacemaker.

Percutaneous Intervention and Follow-up

The coronary angiographic view suggests the culprit's vessel. The therapeutic approach was based on coronary angiograms for all patients. Moreover, coronary angioplasty was performed after the angiogram. Moreover, the pacing procedure was performed according to the guidelines.[17-19] TVP was inserted, followed for several days, and removed before discharge from the hospital if the rhythm recovered. Implantation of permanent pacemaker and ICD after AVB is rare and remains controversial. In the majority of cases, AVB resumes rapidly. If the bradyarrhythmia does not disappear after 1–3 weeks of hospitalization advanced interventional methods (permanent pacemaker or ICD) are tried.

Ethics Statement

The study data were evaluated by double-blinded consultant cardiologists (at least post-fellowship experience of 10 years).

Ethics Approval and Consent to Participate

This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Ethics Committee (Date: 02-03-2021/No: 1829). Informed consent was not required, as this study was conducted retrospectively.

Availability of Data and Materials

All data are available on request at the archive of the S. H. E. T. and R. Hospital Information Management Database.

Statistical Analysis

SPSS Statistics (17.0; IBM) SPSS, Chicago, IL, USA) will be used for statistical analysis. Normally distributed data were determined by the Kolmogorov–Smirnov test. Continuous variables were reported as medians with 25th and 75th percentiles, and categorical variables were expressed as percentages. Moreover, the normal homogeneity of the data was determined by the Anova test. Pearson correlation analysis was used for normally distributed data and the Spearsmen correlation test was used for abnormally distributed data. Mann–Whitney U-test was used for the comparison of median values. Comparisons of categorical variables were made using the Chi-square test. Analysis of variance was used to determine different continuous variables among groups and whether or not they differed from each other. The adjudicated outcomes were tabulated by mortality. The mortality ratio was calculated by dividing the number of patients who died by the total number. Effect modifiers such as ACS type, AVB type, culprit lesion,

baseline characteristics, laboratory findings, vital signs, and left ventricular ejection fraction (LVEF) levels were controlled through stratifications. After stratification, the logistic regression test was applied to evaluate its effects on mortality. Logistic regression analysis was performed to assess the odds ratio (OR) and 95% confidence interval (CI) of death associated with factors. For statistical significance, p<0.05 and 95% CI were accepted.

Results

Clinical, demographic characteristics, comorbidities, and laboratory values are listed in Tables 1 and 2. Two cases required the implantation of a permanent pacemaker before hospital discharge. And two patients needed a pacemaker after hospital discharge.

The mortality rate was 30.59% (26 of 85). Patients in the death group presented with the lower systolic blood pressure (SBP) (OR: 0.922; 95% CI: 0.889–0.957) (p<0.001), heart rate (OR: 0.864; 95% CI: 0.783–0.953) (p=0.004), and older age (OR: 1.060; 95% CI: 1.016–1.105) (p=0.007). Univariate analysis was used to compare both groups using a one-to-one match on mortality by adjusting for confounding factors. Moreover, multivariate model adjustment using step-wise selection demonstrated that admission SBP (OR: 0.912, 95% CI: 0.875–0.951) (p<0.001) and age (OR: 1.088, 95% CI: 1.028–1.151) (p=0.003) are the significant predictors of mortality.

ROC curve analysis showed that a cutoff value of SBP ≤92.5 mmHg had 85% sensitivity and 49% specificity, and age >61.5 years had 81% sensitivity and 54% specificity for predicting mortality (respectively, AUC: 0.8, 95% CI: 0.718–0.946, p<0.001, AUC: 0.7, 95% CI: 0.564–0.825, p<0.004) (Figs. 1, 2).

Only one patient died after discharge from a non-cardiac event. Furthermore, there were no ischemic cardiovascular events seen.

In addition, the study population was analyzed in CAVB and MI subgroups. First, the population was divided into two STEMI category groups according to existence.

Seventy-seven eligible STEMI patients with AVB patients' most common culprit lesion was RCA (61 [79.2%]). Moreover, 71 (92.2%) patients had inferior STEMI. According to AVB type, 72 (93.5%) patients had CAVB.[20] In multivariate analysis, SBP, age emerged as an independent predictor of death (OR: 0.917, 95% CI: 0.879–0.956) (p<0.001), and (OR: 1.107, 95% CI: 1.038–1.181) (p=0.002). As a result, low SBP and elder age were associated with poor prognosis in STEMI patients with AVB.

Among all population, 76 (89.4%) patients presented with CAVB and were included in the CAVB subgroup analysis. Sixty (78.9%) patients had an RCA lesion. The multivariate regression model was used to identify predictors of mortality using clinical characteristics. In the multivariate regression model, SBP (OR: 0.917, 95% CI: 0.879–0.956) (p<0.001) and age (OR: 1.087, 95% CI: 1.028–1.150) (p=0.004) were a predictor of mortality.

Discussion

In our study, some differences were found in the stratification of demographic characteristics according to gender. The male gender has a significant dominance and the age distribution is not homogeneous. Furthermore, females are older than males (p<0.001). In the gender distribution of hypertension, females (n=19, 70.4%) were more statistically significant than males (n=20, 34.5%) (p=0.002).

Table 1. Comparison of baseline demographic and clinical characteristics for mortality

Characteristic	Overall population (n=85) (100%)	Without mortality (n=59) (69.41%)	Mortality (n=26) (30.59%)	p
Gender, male (%)	58 (68.25)	43 (72.9)	15 (57.7)	0.169
Age (years)*	65.0 (57.0–76.0)	62.00	75.50	0.003[a]
Hypertension (%)	39 (45.9)	27 (45.8)	12 (46.2)	0.973
Dyslipidemia (%)	29 (34.1)	24 (40.7)	5 (19.2)	0.061
Diabetes mellitus (%)	50 (58.8)	30 (50.8)	20 (76.9)	0.028[a]
CKD (%)	19 (22.4)	9 (15.3)	10 (38.5)	0.022[a]
Smoking (%)	22 (25.96)	17 (28.8)	5 (19.2)	0.356
Previous stroke (%)	7 (8.2)	3 (5.1)	4 (15.4)	0.129
Previous CABG (%)	4 (4.7)	4 (6.8)	0 (0.0)	0.999
Previous PAD (%)	4 (4.7)	3 (5.1)	1 (3.8)	0.804

*Median (25–75th percentiles), Chronic kidney disease - creatinine >2.0 mg/dl, hemodialysis or renal transplantation. CABG: Coronary artery bypass graft; CKD: Chronic kidney disease; PAD: Peripheral arterial disease. [a]Statistically significant.

Table 2. Comparison of clinical characteristics, electrocardiographic, echocardiographic, and angiographic parameters for mortality

	Overall population (n=85) (100%)	Without mortality (n=59) (69.41%)	Mortality (n=26) (30.59%)	p
Heart rate (beats/minute)*	40.0 (35–45)	40.0	35.0	0.004[a]
SBP (mmHg)*	90.0 (75.00–106.00)	95.0	70.0	<0.001[a]
Admission rhythm type				0.998
1st-degree AVB (%)	2 (2.4)	2 (3.4)	0 (0.0)	N/A
2nd-deg type-1 AVB (%)	2 (2.4)	2 (3.4)	0 (0.0)	N/A
2nd-deg type-2 AVB (%)	5 (5.9)	5 (8.5)	0 (0.0)	N/A
3rd-degree AVB (%)	76 (89.4)	50 (84.7)	26 (100.0)	0.035[a]
PAF (%)	12 (14.12)	8 (13.6)	4 (15.4)	0.824
VT attack (%)	9 (10.6)	6 (6.2)	3 (2.8)	0.85
Biochemical results				
Na (mmol/L)*	138.0 (136.0–140.0)	138.0	138.0	0.847
Creatinine (mg/dl)*	1.0 (0.83–1.47)	0.95	1.535	0.076
AST/ALT (U/L)*	68.0 (25.5–133.5)/28.0 (17.0–49.5)	82.0/28.0	54.25/27.65	0.86/0.85
TG (mg/dL)*	116.0 (82.5–139.75)	121.5	92.5	0.411
HDL (mg/dL)*	37.5 (33.25–46.0)	37.0	39.0	0.855
LDL (mg/dL)*	115.0 (85.0–135.0)	113.0	118.5	0.576
Total cholesterol (mg/dL)*	180.0 (147.25–204.75)	181.5	172.0	0.388
White blood cell (10^9/µL)*	12.20 (9.41–15.25)	11.3	13.5	0.077
Hg (g/dL)*	13.0 (11.55–14.35)	13.3	12.2	0.018[a]
LVEF (%)*	50.0 (42.25–60.0)	35.75	24.35	0.052
Platelet (10^9/µL)*	243.0 (193.5–285.0)	233.0	265.5	0.160
Peak hscTn-I (ng/ml)*	82.65 (12.03–240.93)	92.31	24.83	0.558
Culprit lesion				0.993
RCA (%)	64 (75.3)	47 (79.7)	17 (19.6)	0.16
Cx (%)	8 (9.4)	5 (8.5)	3 (11.5)	N/A
LAD (%)	5 (5.9)	3 (5.1)	2 (7.7)	N/A
Cx and RCA (%)	2 (2.4)	2 (3.4)	0 (0.0)	N/A
LAD and Cx (%)	3 (3.5)	2 (3.4)	1 (3.8)	N/A
LAD and RCA (%)	2 (2.4)	0 (0.0)	2 (7.7)	N/A
LAD, Cx and RCA (%)	1 (1.2)	0 (0.0)	1 (3.8)	N/A
ACS type				0.275
USAP (%)	1 (1.2)	1 (100.0)	0 (0.0)	N/A
NSTEMI (%)	7 (8.2)	6 (85.7)	1 (14.3)	N/A
Inferior STEMI (%)	71 (83.5)	50 (70.4)	21 (29.6)	N/A
Anterior STEMI (%)	6 (7.1)	2 (33.3)	4 (66.7)	N/A
Hospital admission treatment type	0.009a			
Atropine and saline (%)	35 (41.2)	30 (85.7)	5 (14.3)	N/A
Temporary pacing (%)	50 (58.8)	29 (58.0)	21 (42.0)	N/A
Hospital discharge treatment type				
Permanent pace (%)	4 (4.7)	4 (100.0)	0 (0.0)	0.999
ICD (%)	2 (2.4)	2 (100.0)	0 (0.0)	0.999

*Median (25–75th percentiles). ACS: Acute coronary syndrome; ALT: Alanine transaminase; AST: Aspartate transaminase; AVB: Atrioventricular block; Cx: Left circumflex coronary artery; Hg: Hemoglobin; hscTn-I: High sensitivity cardiac troponin-I; ICD: Implantable cardioverter-defibrillator; K: Potassium; Na: Sodium; LAD: Left anterior descending branch artery; LVEF: Left ventricle ejection fraction; NSTEMI: Non-ST-elevation myocardial infarction; PAF: Paroxysmal atrial fibrillation; RCA: Right coronary artery; SBP: Systolic blood pressure; USAP: Unstable angina pectoris; STEMI: ST-segment elevation myocardial infarction; VT: Ventricular tachycardia. [a]Statistically significant.

Moreover, smoking is more significantly observed in males (n=20, 34.5%) than in females (n=2, 7.4%) (p=0.008).

In poor prognostic patients with conduction disorders, a more aggressive therapeutic approach such as TVP seems an appropriate choice which is the main reason for higher mortality in TVP-required patients in the study. Fifty (58.8%) patients were paced temporarily.

CAVB was the most common AVB type demonstrated on our study's admission ECG. That may be because low-degree AVB rhythms are transient and continue clinically be-

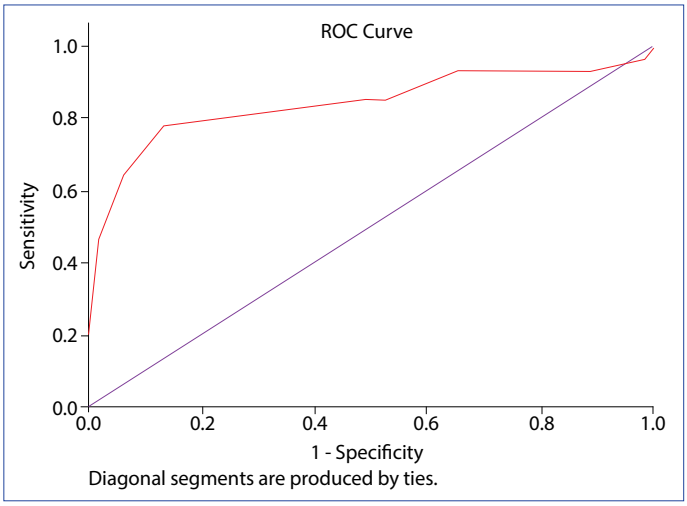

Figure 1. ROC curve analysis demonstrating predictive cutoff value of systolic blood pressure for mortality in ACS patients with AVB.

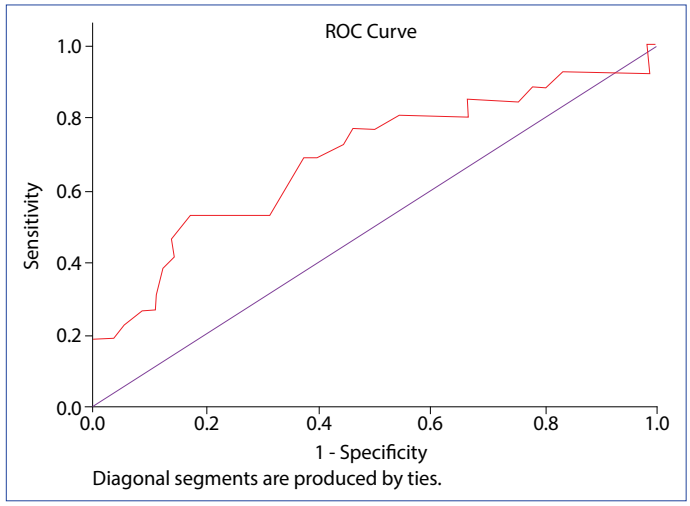

Figure 2. ROC curve analysis demonstrating predictive cutoff value of age for mortality in ACS patients with AVB.

nign, thus not recorded in the hospital database. Even our study, data have a risk of underreporting, as atropine is usually started in an ambulance. These factors could lead to an underestimation of CAVB, even AVB.

AF occurs in 5–18% of patients during periinfarction and hospitalization.[21,22] As expected, mortality in the ACS patients who develop AF is increased.[21-24] Similarly, in the present study, PAF emerged in 12 (14.1%) patients during the ACS period. Three (5.0%) patients were discharged with PAF and 4 (6.66%) with AF rhythm. Patients with PAF during the ACS period were older than those without (75.0 vs. 64.0 years) (z=−1.970; p=0.049). Two patients with PAF attacks needed ICD therapy during hospitalization.

Studies have shown that the development of AVB is more common in patients with inferior STEMI than in patients with anterior STEMI.[10,25] Moreover, the incidence of CAVB with inferior STEMI varies from 7.3% to 13%[13-15] As the same, in our series, inferior STEMI (83.5% [71 of 85]) cases were noted to be present 4 times more frequently than other ACS types (16.5% [14 of 85]). Furthermore, the incidence of RCA lesions (75.3% [64 of 85]) was approximately 2 times higher than those without RCA lesions. Table 2 shows the dominance. Even incidences are much higher in CAVB subgroup analysis RCA lesion (78.9% [60 of 76]) and inferior STEMI (86.8% [66 of 76]); however, this association could not be shown in multivariate analysis.

ACS, in general, has 10–15% mortality. Moreover, the incidence of mortality was higher in ACS patients with conduction arrhythmia. Furthermore, the overall mortality in our population with AVB was ([26 of 85] 30.6%). Even patients who died before hospital admission were not included in our data which could lead to an underestimation of the incidence of mortality. Patients with conduction disorders have higher mortality rates due to more massive MI area and other comorbid conditions, rather than conduction disorders per se.[20] Hence, our high mortality ratio may be due to cases with vast infarction areas rather than the high frequency of CAVB cases. However, no significant relationship was found between mortality ratio and peak high sensitivity cardiac troponin I (hscTnI) levels, an indicator of infarction area. Some patients' hscTnI levels are added to the study lower than they should be. Because we did not evaluate further elevation of hscTnI levels as some patients died during the angioplasty. Moreover, they were included within normal limits, which could lead to an underestimation of hscTnI levels and their relation with factors.

Sixty (71%) patients were discharged and in-hospital cardiac death occurred in 25 (29.4%) patients. Of the 60, only one patient died from a non-cardiac problem during the follow-up period. In our series, there was no death due to cardiac problems after discharge. Although we evaluated in-hospital and 5-year follow-up mortality rates, mortality rates may be confined to the in-hospital ratio only. Some studies have shown low-grade AVB (1st and 2nd-degree Type 1) has no excess in-hospital mortality compared with MI patients with no AVB.[13] Likewise, our recent study observed no mortality among patients with the lower degree blocks than CAVB. All deaths occurred in patients with CAVB. Even in patients admitted with CAVB rhythm, the mortality ratio climbs to 34.21% (26 of 76). However, in contrast to some previous studies, in our cases, no relationship was found between the death ratio and AVB types (p=0.998).[13,14] Even AVB types had a relation with mortality predictors (lower SBP (p=0.017) and heart rate (p=0.002)). Reason for inconsistency; in our study, most of our patients (76 [89.4%]) had CAVB, and the number of cases with other types of AVB (9 [10.6%]) was too small

for adequate statistical evaluation. Moreover, our study had a relatively short-term (5-year) follow-up.

For patients with admission CAVB rhythm, mortality was 34.2% (26 out of 76). Furthermore, mortality in TVP patients was 42.0% (21 of 50). The difference in mortality rates between the groups may be due to different baseline characteristics and the hospital course rather than the impact of the procedure itself.

In contrast to earlier studies with high mortality rates in females and significantly increased AVB degree,[15] our study found no relation between gender, AVB degree, and mortality. The association between lower LVEF and mortality was known, but lower LVEF levels did not result in a statistically demonstrable effect on mortality in our study. Although such assessment is because of the entrance, there are not enough patients to study for further evaluation.

Age and admission vital signs play a crucial role in the prognostic assessment of ACS patients with AVB. Hence, age and admission vital signs help the clinician identify advanced-grade ACS patients with AVB at the initial evaluation. That shows the importance of monitoring. Poor vital findings, AVB, or even CAVB usually resolve after angioplasty. Nevertheless, ACS patients with the lower heart rates, hypotension, or AVB should not be considered benign or transient findings. In poor prognostic ACS patients associated with conduction disorders, a more aggressive therapeutic approach seems to be an appropriate choice to warrant after acute STEMI. Patients with ACS and high degree AVB were suitable for TVP.[26] Otherwise, unnecessary TVP causes to loss of critical PCI procedure time. Even TVP leads to losing valuable time in the angiogram laboratory and increases the risk of femoral access site bleeding complications, even can cause life-threatening complications like a cardiac rupture. Therapeutic efforts should be targeted at the identification and revascularization of the culprit lesion. It was expected that the incidence of AVB would be decreased by introducing newer treatment methods that aimed to maintain coronary circulation. However, ECG findings, such as AVB type, are not influential in determining the short-term prognosis and do not show a relationship with mortality.

Study Limitations

Our study is only a single-center, retrospective, non-randomized, and observational study and has the intrinsic limitations of such a design.

Conclusion

Our study has shown that the incidence of mortality in ACS patients with AVB remains high, and conduction blocks in long-term follow-up of ACS patients had no cardiac mortality. Aggressive supportive care and temporary cardiac pacing may be necessary to improve the outcome of this severe complication, especially in elderly patients with compromised vital signs.

Disclosures

Ethics Committee Approval: This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Ethics Committee (Date: 02-03-2021/No: 1829).

Peer-review: Externally peer-reviewed.

Conflict of Interest: None declared.

Authorship Contributions: CoConception – M.C.S.; Design – A.G.; Supervision – E.K.; Materials – O.A.; Data Collection and/or processing – K.K.; Analysis and interpretation – S.S.; Literature search – O.A., H.K.; Writing – M.C.S.; Critical Review – K.K., H.K.

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