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What is the Role of Metabolic Syndrome and Obesity for Postoperative Atrial Fibrillation after Coronary Bypass Grafting?

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Background: We aimed to determine whether obesity and metabolic syndrome are independent risk factors in postoperative atrial fibrillation and if so, to determine the magnitude of their effect. We also analyzed the effect of postoperative atrial fibrillation on cardiac surgical complications.

Materials and Methods: We retrospectively evaluated 756 patients undergone coronary bypass surgery between June 2010 and September 2017 in our clinic. The cases with and without atrial fibrillation were evaluated in terms of postoperative complications, length of hospitalization and mortality rates. The first endpoint in the study was the detection of atrial fibrillation while the second was the discharge time.

Results: In the study, metabolic syndrome, diabetes mellitus, hypertension, and obesity between the ages of 56-78 were found to affect the development of postoperative atrial fibrillation 2.46, 2.3, 1.6, and 1.65 times, respectively. In cases with postoperative atrial fibrillation, infection and stroke were 1.45 and 8.85 times more frequent, respectively. Patients with metabolic syndrome were found to have 31% more prolonged hospitalization, 17% more frequent infection, and 39.1% more frequent hypertension. Obese cases had 23.5% more prolonged stay.

Conclusion: In the study, obesity was found to be an independent risk factor for postoperative atrial fibrillation. Patients with metabolic syndrome and obesity who developed postoperative atrial fibrillation had higher rate of stroke and longer period of hospitalization. If causes and mechanisms of postoperative atrial fibrillation are identified in planned cardiovascular interventions, we believe that cost of hospitalization and morbidity reduces.

Keywords: Metabolic syndrome, obesity, atrial fibrillation, coronary bypass grafting, postoperative evaluations

Introduction

Any three of the following traits in the same individual meet the criteria for the metabolic syndrome: Abdominal obesity, increased serum triglycerides (150 mg/dl or above), increased HDL cholesterol (40 mg/dl or lower in men and 50mg/dl or lower in women), blood pressure of 130/85 mmHg or more, fasting blood glucose of 100 mg/dl or above. 27% incidence was reported in the USA over the age of 20 years (1). Kozan et al. reported that in Turkey, metabolic syndrome was seen in 33,9% of the population over 20 years of age and more frequently in women (2). These data were obtained when the upper limit of the waist circumference is 102 cm for men and 88 cm for

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women. We believe that today's current upper limits of 94 and 80 cm increase these rates. In MS, increased circulating cytokines secondary to metabolic disorders are thought to stimulate atrial fibrillation (AF). The incidence of AF is 0,4% in the general population, 30-40% after coronary artery bypass grafting (CABG), and 60% after valve surgery (3). In the USA, it is known that AF-caused hospital admissions have increased by 66% over the last 20 years (4). Postoperative atrial fibrillation (POAF) has been reported to increase hospital admissions in the US by ~30 days, resulting in an additional cost of $18000-19000 and 2 or 3-fold increase in stroke risk (5). Watanabe et al. demonstrated that metabolic syndrome is an independent risk factor for AF development even in the absence of diabetes and hypertension and is strongly associated with stroke, myocardial infarction, and all-cause mortality (6).

The study aimed to evaluate whether obesity and metabolic syndrome are independent risk factors among the risk factors affecting POAF formation in the literature. We also analyzed the effect of factors that stimulated POAF formation on postoperative complications and length of hospital stay.

Materials and Methods

756 patients who underwent isolated CABG between June 2010 and September 2017 were evaluated retrospectively. Health Sciences University of Siyami Ersek Cardiovascular Surgery Hospital Ethics Committee approved the study with the number: 28001928-501 07.01. Informed consent was waived by the Institutional Review Board owing to the study's retrospective nature.Patients with preoperative Atrial fibrillation treatment(1), additional cardiac interventions(2), hyperthyroidism(3), moderate-to-severe (4) liver and (5) renal failure, (6) malignancy and those with no available record of body mass index (BMI), waist circumference (WC) measurements were excluded.

Table-1 shows the demographic characteristics of the cases [age, gender, drugs used (statin, beta blocker, ACE inhibitors), smoking, BMI, history of diabetes mellitus (DM), hypertension (HT), Chronic obstructive pulmonary disease (COPD) and post-myocardial infarction (MI), measurements of triglyceride (TG), high-density lipoprotein (HDL), waist circumference and left ventricular ejection fraction (LVEF). Peri operatively, total and partial cardiopulmonary bypass (CPB) time, IABP use, and the number of bypasses were determined. Postoperatively, infection, stroke, hemorrhage, duration of ICU and hospitalization and mortality were evaluated (Graph-2). POAF formation of MS and obesity cases were compared to each other and to non-AF cases.

For the diagnosis of MS, diagnostic criteria proposed by MS Working Group of The Society of Endocrinology and Metabolism of Turkey (2005) were taken as the basis (7). Accordingly, to establish the MS diagnosis, in addition to presence of at least one of the parameters of diabetes mellitus, impaired glucose tolerance or insulin resistance, having at least two of following parameters: (I) hypertension (systolic >130 mmHg, diastolic>85 mmHg or being under antihypertensive drug), (II) dyslipidemia (TG>150 mg/dl or HDL≤40 mg/dl for male/50 mg/dl for female), (III) abdominal obesity (BMI> 30 kg/m^2 or WC>94 cm for male and >80 cm for female) was required.

Waist circumference was measured through the middle of the distance between the arcus costarium and the spina iliaca anterior superior. BMI was used for the detection of obesity.

The cases were followed by continuous ECG monitoring for the first 24 h postoperatively while daily 12-lead ECG record was used for rhythm follow-up on other days. Patients with AF rhythm were monitored until the sinus rhythm was restored. Also, ECG recording was taken in case of arrhythmia. Amiodarone hydrochloride loading and maintenance doses (8 ampoules /1200 mg in 500cc 5% Dextrose solution) were administered to patients who developed AF rhythm. Loading dose of 5-10 mg/kg was administered intravenously within the first 30 minutes. Maintenance dose was administered as 36-60 mg/h (900-1500 mg/ day). Oral amiodarone (200 mg; 2x1) started after 24 hours. Low-molecular-weight heparin (enoxaparin sodium 75 IU/kg) was given to patients with AF. Mechanical cardioversion was applied to the cases resistant to medical cardioversion within first 24 hours. All cases were continued postoperatively to the beta blocker, statin and ACE inhibitor used before the operation. In the study, the first endpoint was the detection of atrial fibrillation and the second endpoint was the discharge time.

Statistical analysis

Continuous variables were expressed as a mean and standard deviation, while intermittent variables were expressed as number and percentage. Shapiro-Wilk test was used to determine whether the data were normally distributed. In the independent, continuous and normally distributed variables, Student's t-test was used for binary comparisons whereas ANOVA F-test was used for triple or more comparisons. Mann Whitney U-test was used for binary comparison of non-normally distributed variables while the Kruskal Wallis H-test was used for triple or more comparisons. Chi-square, Fisher exact and Yates continuity-correction tests were used for comparison and risk analysis of the nominal data of the two groups. The relationship between the groups was analyzed by the Pearson correlation test. Logistic regression was used to determine the effect of dependent and independent factors of POAF. The data were analyzed with the SPSS 17,0 statistical program for Windows. The number of samples was determined such that $\alpha \leq 0,05$ and $\beta \leq 0,20$ in the study. Values of $p \leq 0,05$ were considered significant.

Results

Of the 756 cases (mean age: 58,7±12,8; male: 527) included in the study, 21,3% (n: 161) had POAF. In 88% of cases with POAF (n: 142), AF rhythm occurred within 1-5 days. In 98% (n: 158) of cases with POAF, sinus rhythm was restored within 1-3 days. AF rhythm developed in 23% (n:52) of female cases and in 21% (n: 109) of males. Distribution by sex was not significant (p=0,532). Difference was significant in obese cases (BMI≥30 kg/m^2; p=0,001; Table-1). It was found that 33% (n:74; p=0,001) of cases with MS, 23% (n:16; p=0,84) of Statin users, 24% (n:66; p=0,275) of ACE inhibitor users, 17% (n:40; P=0,059) of beta-blocker users, 21% (n:50; P=0,739) of smokers and 20% (n:43) of cases with COPD developed POAF (Table-1). The development of POAF was found to increase length of hospitalization by 20,7% (p=0,001). POAF development was associated with BMI by 16,9% (p=0,001), with WC by 24,7% (p=0,001), and with age by 7,3% (p=0,044; Graph-1 and 3; Table-1). The mean of waist circumference was 90,1±12,6 cm in the cases with POAF while was 81,6±14 cm in the other cases. The difference was significant (p=0,004). Incidence of post-operative atrial fibrillation was increased by 2,46 times (n:74; OR:2,46; 95% CI:1,7-3,5) in cases with MS, by

Table-1. Statistical analysis of cases according to POAF and Metabolic Syndrome status

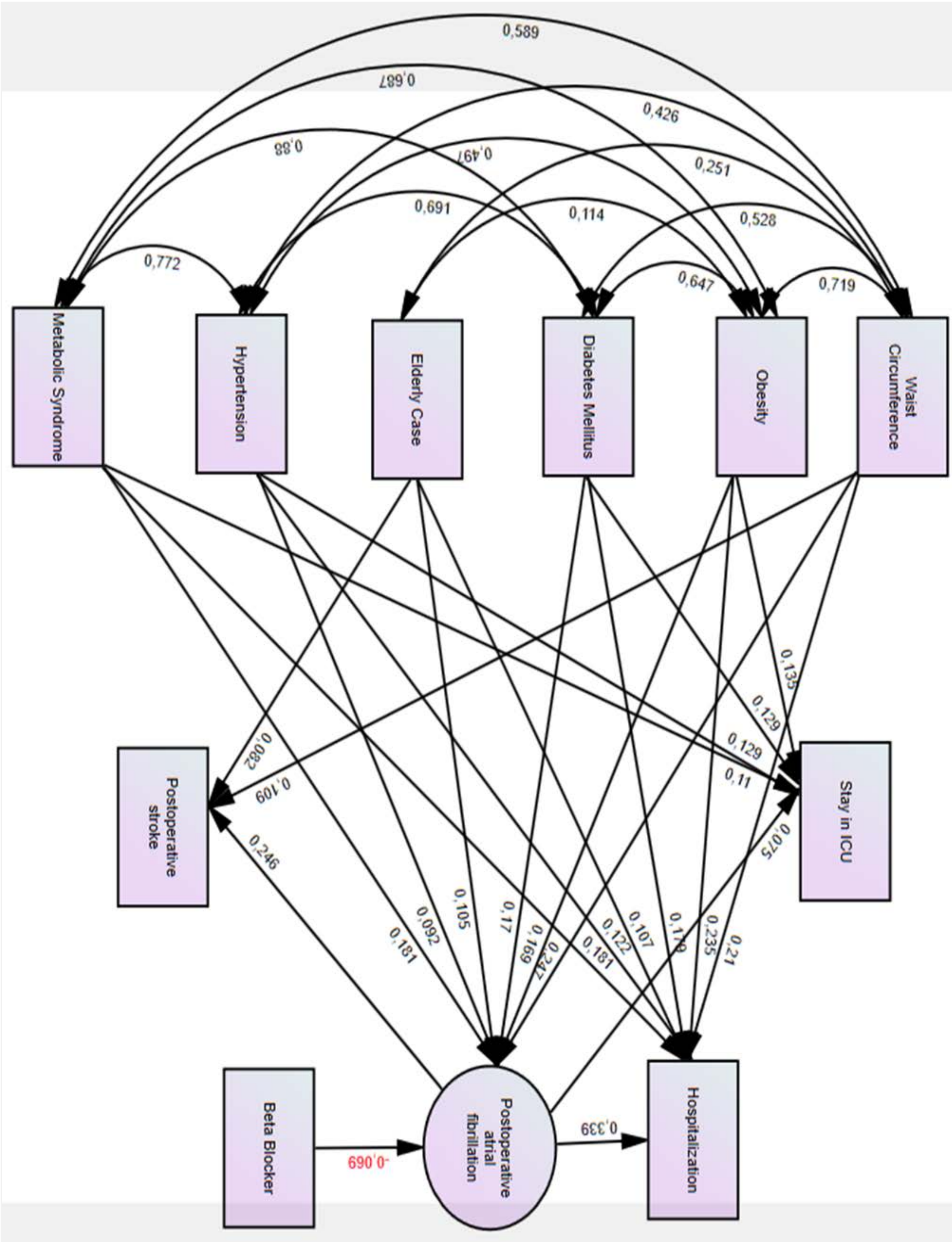
Variables		Postoperative Atrial Fibrillation												
		Unavailable						Available						Total p(b)
		Metabolic Syndrome						Metabolic Syndrome						
		Unavailable		Available		Total	P(b)	Unavailable		Available		Total	P(b)	
		n	%	n	%			n	%	n	%			
Gender	Female	132	74,6	45	25,4	177	0,92	30	57,7	22	42,3	52	0,52	0,53
	Male	310	74,2	108	25,8	418		57	52,3	52	47,7	109		
Age	18-35	21	75,0	7	25,0	28	0,01	3	50,0	3	50,0	6	0,38	0,01
	35-55	185	76,4	57	23,6	242		21	45,7	25	54,3	46		
	55-80	236	72,6	89	27,4	325		63	57,8	46	42,2	109		
BMI	<25	249	100	0	0,0	249	0,01	35	89,7	4	10,3	39	0,01	0,01
	25-30	173	83,6	34	16,4	207		42	70,0	18	30,0	60		
	>30	20	14,4	119	85,6	139		10	16,1	52	83,9	62		
ACE Use	(-)	362	95,5	17	4,5	379	0,01	72	75,8	23	24,2	95	0,01	0,27
	(+)	80	37,0	136	63,0	216		15	22,7	51	77,3	66		
Statin Use	(-)	421	78,1	118	21,9	539	0,01	83	57,2	62	42,8	145	0,01	0,84
	(+)	21	37,5	35	62,5	56		4	25,0	12	75,0	16		
Beta-Blocker Use	(-)	302	75,3	99	24,7	401	0,41	63	52,1	58	47,9	121	0,38	0,05
	(+)	140	72,2	54	27,8	194		24	60,0	16	40,0	40		
Cigaret Use	(-)	296	73,6	106	26,4	402	0,60	61	55,0	50	45,0	111	0,73	0,74
	(+)	146	75,6	47	24,4	193		26	52,0	24	48,0	50		
Hypertension	(-)	406	95,8	18	4,2	424	0,01	83	84,7	15	15,3	98	0,01	0,01
	(+)	36	21,1	135	78,9	171		4	6,3	59	93,7	63		
Diabetes Mellitus	(-)	409	99,8	1	0,2	410	0,01	79	100,0	0	0,0	79	0,01	0,01
	(+)	33	17,8	152	82,2	185		8	9,8	74	90,2	82		
COPD	(-)	316	74,5	108	25,5	424	0,83	63	53,4	55	46,6	118	0,79	0,61
	(+)	126	73,7	45	26,3	171		24	55,8	19	44,2	43		
MI (passed)	(-)	390	74,7	132	25,3	522	0,52	73	52,9	65	47,1	138	0,48	0,49
	(+)	52	71,2	21	28,8	73		14	60,9	9	39,1	23		
IABP	(-)	415	73,7	148	26,3	563	0,18	81	54,0	69	46,0	150	0,97	0,48
	(+)	27	84,4	5	15,6	32		6	54,5	5	45,5	11		
		Ort.	ss	Ort.	ss	Ort.	p(a)	Ort.	ss	Ort	ss	Ort	P(a)	Total p(a)
TG (mg/dl)		170,0	33,2	200,4	56,3	185,2	0,01	169,2	34,3	187,6	48,4	178,4	0,01	0,96
HDL(mg/dl)		38,9	7,5	37,0	6,5	38,0	0,01	39,1	6,9	38,2	7,2	38,7	0,44	0,67
Total CPB (/min)		86,2	6,5	86,4	7,2	86,3	0,82	84,7	6,1	87,2	7,7	86,0	0,02	0,53
CCT(/min)		56,2	6,5	56,4	7,2	56,3	0,82	54,7	6,1	57,2	7,7	56,0	0,02	0,54
LVEF (%)		51,1	7,9	49,7	9,0	50,4	0,06	49,7	9,4	48,9	9,2	49,3	0,57	0,08
Hospitalization (/day)		7,8	1,6	8,3	1,9	8,1	0,01	8,7	1,5	9,1	2,1	8,9	0,11	0,01
CABG		2,9	0,4	2,9	0,4	2,9	0,85	2,8	0,4	2,9	0,4	2,8	0,18	0,39
Waist circumference(cm)		76,9	11,8	95,3	10,6	86,1	0,01	84,5	11,6	96,8	10,4	90,6	0,01	0,01

p(a): Independent sample t-test, p(b): Pearson chi-square test; $p<0.05$ was considered significant. CPB:Cardiopulmonary bypass, IABP: Intraaortic balloon pump, MI: Myocardial infarction, TG: Triglyceride, (+): available, (-): unavailable

Table-2. The preoperative demographic characteristics of patients and analysis of effect on mortality, hospitalization, ICU stay, stroke, infection and bleeding

Variables		Mortality		p^b	Hospitalization		p^a	ICU Stay		p^a	Stroke		p^b	Infection		p^b	Bleeding		p^b
		Not	Yes		Ort.	Ss		Ort.	Ss		Not	Yes		Not	Yes		Not	Yes	
Gender	Female	225	4	0,54	8,2	1,94	0,41	1,9	1,8	0,66	217	12	0,52	209	20	0,47	223	6	0,42
	Male	514	13		8,1	1,71		1,9	1,7		505	22		489	38		507	20	
ACE	(-)	465	9	0,40	8,1	1,77	0,04	1,8	1,7	0,27	452	22	0,80	444	30	0,07	457	17	0,77
	(+)	274	8		8,3	1,79		2,0	1,8		270	12		254	28		273	9	
Statin Use	(-)	667	17	0,35	8,1	1,76	0,15	1,9	1,8	0,44	651	33	0,18	633	51	0,49	661	23	0,73
	(+)	72	0		8,4	1,94		1,8	0,8		71	1		65	7		69	3	
Beta Blocker	(-)	510	12	0,89	8,1	1,72	0,80	1,9	1,7	0,74	496	26	0,34	482	40	0,99	505	17	0,68
	(+)	229	5		8,2	1,91		1,9	1,7		226	8		216	18		225	9	
POAF	(-)	581	14	0,71	8,0	1,72	0,01	1,9	1,7	0,24	584	11	0,01	553	42	0,24	573	22	0,45
	(+)	158	3		8,9	1,82		2,0	1,7		138	23		145	16		157	4	
Metabolic Syndrome	(-)	519	10	0,31	8,0	1,64	0,01	1,8	1,5	0,02	510	19	0,07	496	33	0,02	509	20	0,43
	(+)	220	7		8,6	2,02		2,1	2,1		212	15		202	25		221	6	
HT	(-)	513	9	0,15	8,0	1,70	0,01	1,8	1,6	0,01	501	21	0,35	486	36	0,23	502	20	0,38
	(+)	226	8		8,4	1,94		2,1	2,0		221	13		212	22		228	6	
Diabetes Mellitus	(-)	479	10	0,61	8,0	1,63	0,01	1,8	1,5	0,01	472	17	0,07	458	31	0,06	473	16	0,73
	(+)	260	7		8,5	1,98		2,1	2,0		250	17		240	27		257	10	
BMI	<25	283	5	0,39	7,8	1,46	$0,01^c$	1,8	1,6	$0,06^c$	278	10	0,27	282	6	0,01	281	7	0,49
	25-30	262	5		8,2	1,78		1,8	1,6		256	11		242	25		256	11	
	>30	194	7		8,7	2,06		2,1	2,0		188	13		174	27		193	8	
Cigaret Use	(-)	502	11	0,78	8,3	1,95	0,01	2,0	1,9	0,01	487	26	0,27	470	43	0,29	492	21	0,15
	(+)	237	6		7,9	1,35		1,7	1,3		235	8		228	15		238	5	
COPD	(-)	527	15	0,13	8,3	1,93	0,01	2,0	1,9	0,01	514	28	0,16	496	46	0,18	522	20	0,55
	(+)	212	2		7,9	1,29		1,6	1,1		208	6		202	12		208	6	
Age	18-35	32	2	0,20	8,0	2,24	$0,12^c$	2,1	1,8	$0,52^c$	33	1	0,07	32	2	0,03	31	3	0,02
	35-55	280	8		8,0	1,67		1,8	1,6		281	7		275	13		277	11	
	55-80	427	7		8,3	1,81		1,9	1,8		408	26		391	43		422	12	

ACE: angiotensin converting enzyme, HT: hypertension, COPD: Chronic Obstructive Lung Disease, pb: Pearson Chi-square test, pa: Independent Sample t-test, pc: One Way Anova test



Graph-1. Significance rates of factors affecting postoperative atrial fibrillation stay in ICU, hospitalization and stroke and r correlation coefficients

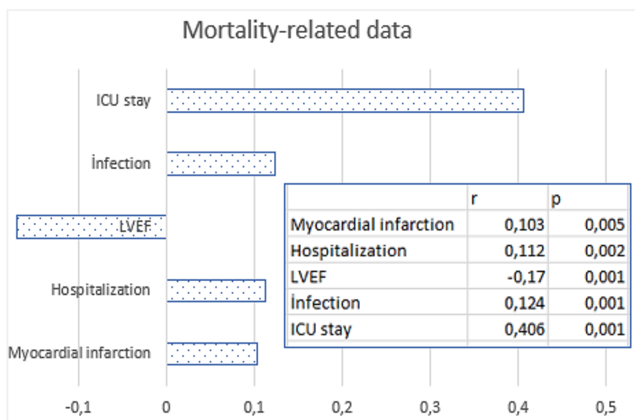
2,3 times (n:82; OR:2.3; 95% CI:1,61-3,3) in cases with DM, and by 1,6 times (n:63; OR:1,59; 95% CI:1,1-2,3) in hypertensive cases. The post operative infection and stroke were 1.45 times (n:16; OR: 1.45; 95% CI: 0.794-2.66) and 8.8 times (n:23; odds ratio: 8.84; %95 CI:4,2-18,5), respectively, more frequent in these cases. There was no relationship between mortality and POAF.

MS was present in 29,5% of the female cases (n:67; p=0,7661). 31% of POAF cases (n:135) were in the 56-78 age group. POAF occurred in 46% of cases with MS (n:74; p=0,001; Table-2). When cases with MS who developed POAF were evaluated alone, lengths of hospitalization and intensive care unit stay were found to be increased by 18,1% (0,6/day) and by 11% (0,3/day), respectively. 43% of postop infections (n:25; p=0,024; OR:1,86 95% CI:1,08-3,2) and 44% of strokes (n:15; OR:1,9; 95% CI: 0,95-3,8) were found to be occurred in cases with MS (Table-2). Mortality was found to be 1,7 times more in cases with MS (n:7; p=0,310; OR:1,65; 95% CI:0,62-4,39; Table-2).

Of the 201 patients (26,6%) who were obese according to BMI, 30,8% was found to have POAF (30,8%; n:62; p=0,001) and the difference was significant compared to normal cases. 13,4% of the postoperative infections (n:27; p=0,001) were seen in this group. There was a significant positive correlation between post operative infection and BMI (17%; p=0,001). However, there was a low positive correlation with stroke (p=0,292; Graph-4). Mortality was higher than the other groups (3,5%) but the relationship was not significant (p=0,38; Graph-2). In the obese cases, the hospitalization period was found to be 23,5% longer. Obesity increased the risk of AF by 1,65-fold (n:62; OR:1,65; 95% CI:1,4-1,9) in 56-78 age group.

There was a positive correlation between age and AF (p=0,010; Graph-3). AF developed in 17,6% of the cases (n:6) belonging to the 18-35 age group, in 16% of the cases (n:46) belonging to the 36-55 and in 25% of the cases (n:109) belonging to the 56-78 age group. 67,7% of cases with AF were in the 56-78 age group (p=0,012). The rate of postoperative infection in the same age group was 9,9% (p=0.026). Effect of the age on the length of hospitalization in the AF developed cases was found to be 10,7% (p=0,012) and that was statistically significant. There was a 6% relationship between stroke and age but not significant (n:26; p=0,058).

When patients with the metabolic syndrome were evaluated in terms of AF occurrence, the increase in AF risk was not significant in the 18-35 age group (p=0,223), was 3,7 times in the 35-55 age group (p=0,001; OR:3,86; 95% CI:2,01-7,41), and was 1.9 times in the 56-79 age group (p=0,001; OR:1,96; 95% CI:1,23-3,04; Table-1).



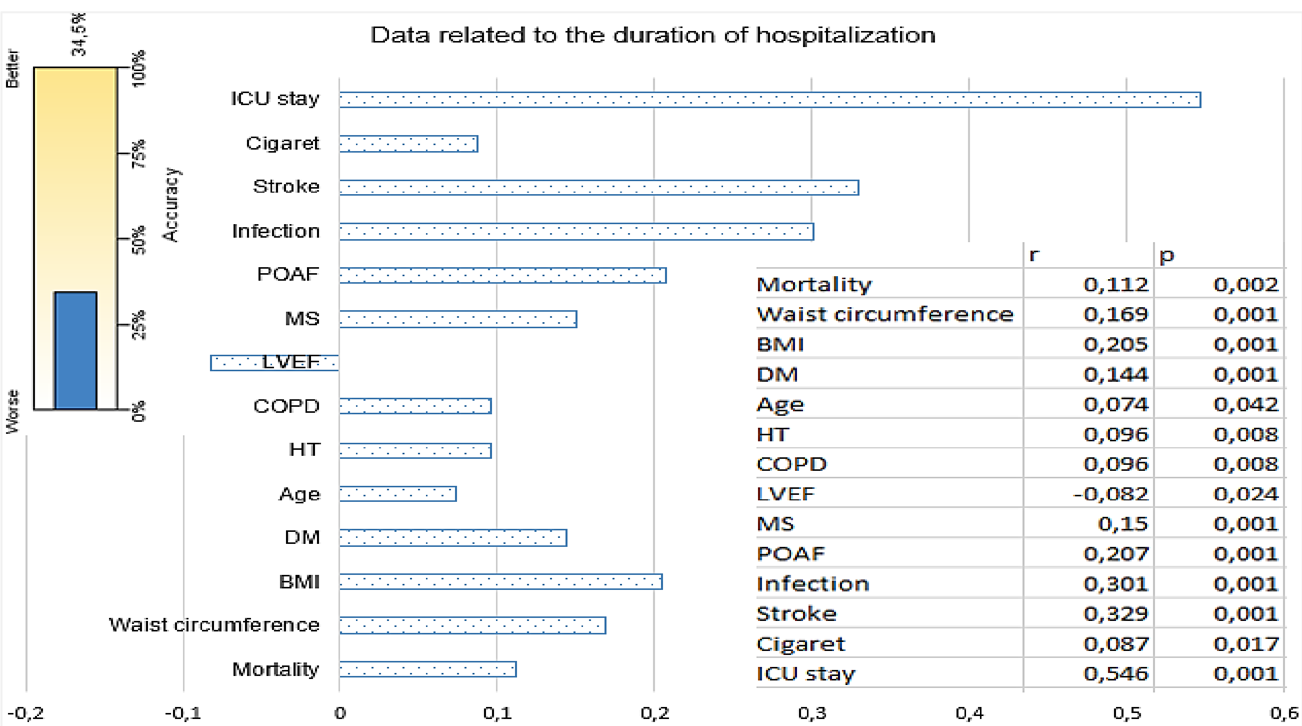
Graph-2. Distribution of mortality related data

Hypertension was diagnosed in 31% (n:234) of the cases. In 26,9% (n:63; p=0,011) of hypertensive cases, POAF developed and the relation was significant. MS was detected in 82,9% of hypertensive patients (n:194). The length of hospitalization and intensive care unit stay of these cases was longer than other case by 9,6% and 8,9%, respectively. At the same time, BMI's were significantly higher in these cases (p=0,001). Hypertension was found to increase the AF incidence by 1,6-fold (p=0,011; OR:1,59 %95 CI:1,11-2,29), infection incidence by 1,4-fold (p=0,232; OR:1,43; %95 CI:0,80-2,43), and mortality by 2-fold (%3,4; p=0,146; OR:2,01; %95 CI:0,77-5,29).

When the factors affecting the duration of hospitalization were examined (Table-2), the POAF was found to be the major contributing factor by 34%. The effect of such factors as BMI and WC on the length of hospital stay was 21-23% (Graph-1). Cases with Diabetes Mellitus and MS were found to have longer duration of hospitalization by 18% (Graph-1). Duration of hospitalization was significantly prolonged by infection (23,2%; p=0,001), stroke (24,5%; p=0,001), low LVEF (7%; p=0,035), and age (11,3%; p=0,002; Graph-3 and 5).

Discussion

Many studies, report 15-40% AF development incidence within 1-5 days after surgery (8). Its clinical significance depends on the underlying factor. Within the first 2 h, 30% of POAF cases recover spontaneously. It has been reported that 25-80% of POAF cases recover in 24 hours by using only the digoxin (9). Mathew et al. reported higher rates of POAF with older age, male gender, hypertension, history of AF rhythm, heart failure, valve disease, COPD, and preoperative use of digoxin, without beta-blockers (10). The incidence of POAF has been reported be more in cases whose surgery encompasses pulmonary vent placement and/or bicaval cannulation (10). Since our series consisted of coronary artery bypass cases, bicaval cannulation and pulmonary venting were not performed. 88% of POAF's developed within postoperative 1-5th days and 98% of these recovered within 1-3 days. As the LVEF

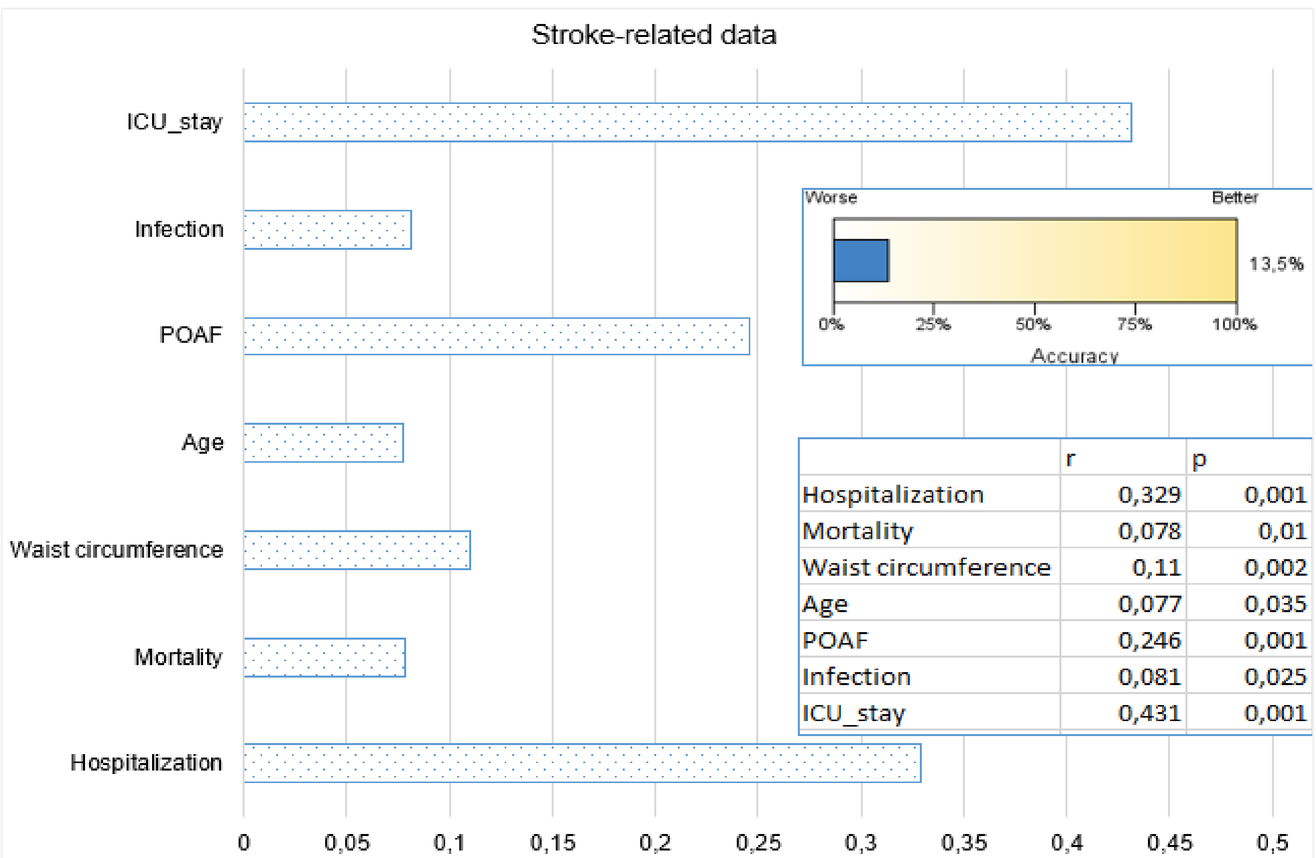


	r	p
Mortality	0,112	0,002
Waist circumference	0,169	0,001
BMI	0,205	0,001
DM	0,144	0,001
Age	0,074	0,042
HT	0,096	0,008
COPD	0,096	0,008
LVEF	-0,082	0,024
MS	0,15	0,001
POAF	0,207	0,001
Infection	0,301	0,001
Stroke	0,329	0,001
Cigaret	0,087	0,017
ICU stay	0,546	0,001

Graph-3. Distribution of the proportions of data (r = correlation coefficient) related to the hospitalization period in all cases. The data reveal 34.5% of the hospitalization period.

value decreased, incidence of POAF increased but relationship was not significant. Significant results may be obtained, however, in the series in which very low LVEF cases are included. In our cases, it was found that DM, MS, obesity, and advanced age had affected POAF positively. On the other hand, significant negative correlation (6,9%; p=0,05) between POAF and beta-blocker use was detected (Table-1; Graph-1). However, Statin and ACE inhibitor use were not found to be correlated with POAF. Mathew et al. have found an association between ACE inhibitor or Statin use and POAF, which can be explained by the fact that the number of cases using these drugs was higher than our count. It was found that POAF significantly increased length of hospitalization and ICU stay, and the stroke rate (Graph-6).

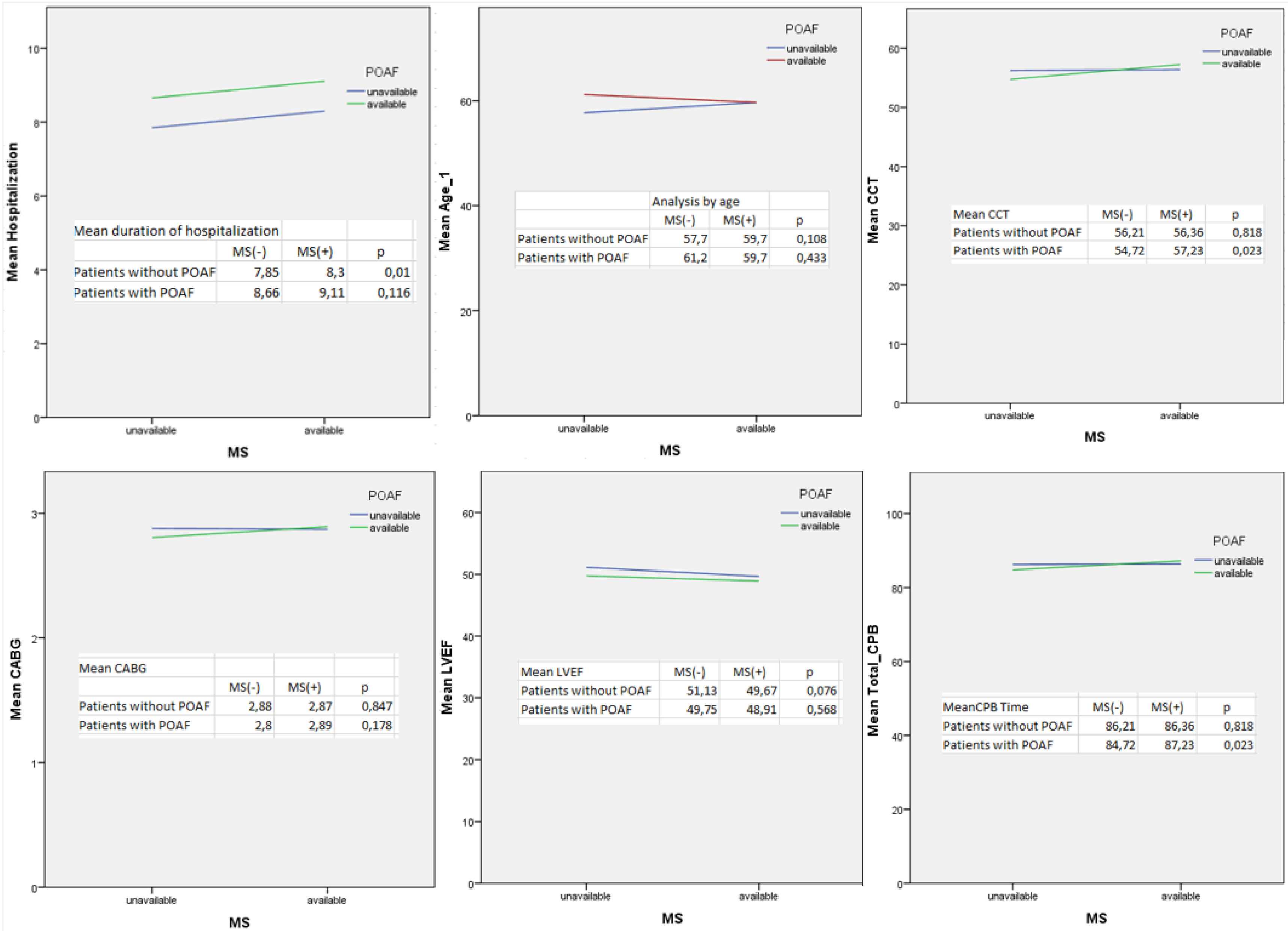
Roffman et al reported that as the number of bypass grafts or the cardiopulmonary bypass time increases, the rate of arrhythmia increases (11). Bannister et al proposed that hypothermia, hemodilution and nonpulsatile current increase insulin, renin and prostaglandin release. However, the mechanism by which glucose is transported into the cell is affected and blood glucose level is elevated. As a result, metabolic acidosis occurs. When the patient is warming up, the insulin response increases but hyper glycemia persists for another 1-2 hours. In addition, the metabolism of thyroid hormones is affected and the level of triiodothyronine falls (12). In our study, there was no difference between the number of bypasses, and total and partial CPB times of the cases. If studies with groups with different total and partial CPB



	r	p
Hospitalization	0,329	0,001
Mortality	0,078	0,01
Waist circumference	0,11	0,002
Age	0,077	0,035
POAF	0,246	0,001
Infection	0,081	0,025
ICU_stay	0,431	0,001

Graph-4. When all cases are considered, a graphical representation of the ratio of stroke-related data (r=correlation coefficient). The data reveals only 13.5% of strokes.

Graph-5. In cases with and without POAF, according to MS status; Hospitalization duration, age, CCT, total CPB duration, mean CABG number and LVEF were compared. Total CPB and CCT times were significantly longer in POAF and MS. In addition, MS alone extended length of hospitalization significantly



Mean duration of hospitalization			
	MS(-)	MS(+)	p
Patients without POAF	7,85	8,3	0,01
Patients with POAF	8,66	9,11	0,116

	Analysis by age		
	MS(-)	MS(+)	p
Patients without POAF	57,7	59,7	0,108
Patients with POAF	61,2	59,7	0,433

Mean CCT	MS(-)	MS(+)	p
Patients without POAF	56,21	56,36	0,818
Patients with POAF	54,72	57,23	0,023

Mean CABG			
	MS(-)	MS(+)	p
Patients without POAF	2,88	2,87	0,847
Patients with POAF	2,8	2,89	0,178

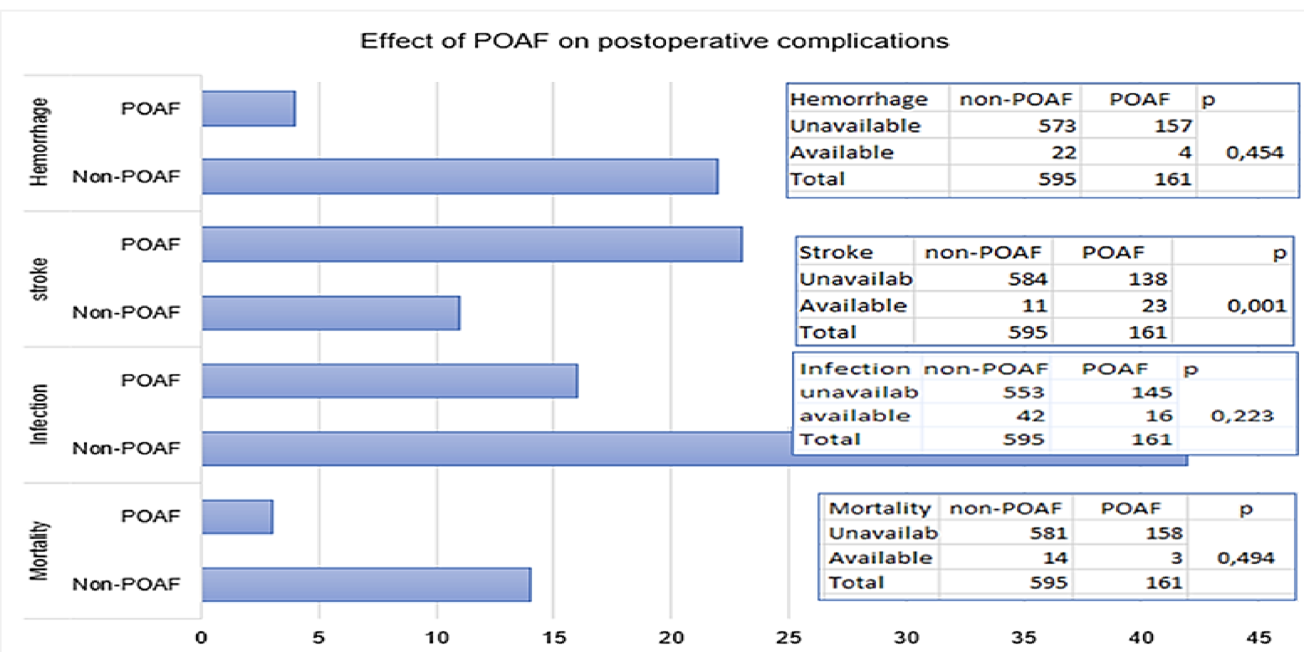
Mean LVEF	MS(-)	MS(+)	p
Patients without POAF	51,13	49,67	0,076
Patients with POAF	49,75	48,91	0,568

MeanCPB Time	MS(-)	MS(+)	p
Patients without POAF	86,21	86,36	0,818
Patients with POAF	84,72	87,23	0,023

durations are performed, it can be analyzed whether this difference is a factor affecting POAF.

Studies have reported 34% prevalence of abdominal obesity in a population of 20 years of age and over in Turkey (13). Although abdominal obesity is an important indicator of insulin resistance, obesity may not be present in some of the metabolic syndrome cases with insulin resistance. As the BMI's increases, there is a gradual increase in left atrial dimensions. Ducceschi et al reported that they found higher frequency of AF and left atrial dilatation in a series of 150 cases with BMI ≥30 kg/m^2 (14). In atrial biopsies of patients with atrial fibrillation, inflammatory mediators were detected high. This may explain development of AF from postoperative inflammation (15). It is believed that abdominal obesity increases the level of inflammatory cells and facilitates development of AF with the released mediators. Adipose tissue is an active endocrine organ that secretes many hormones like leptin, resistin, adipo nectin, and cytokines (TNF-alpha,IL-6). These Released cytokines cause inflammation and affect the insulin resistance and pulmonary functions (16). In our study, we found that both high BMI measurements and high WC scores affected POAF significantly (p=0,001). The mean WC value was 90,1±12,6 cm in the POAF developed cases while it was 81,6±14cm in the cases that had not developed POAF.

The body mass index is an indicator of total fat accumulation and does not represent the distribution of fat or metabolic distress. It has also been reported in previous studies that obesity is defined by BMI and is an independent risk factor for POAF (17). There have been recent reports that obesity has no effect on POAF (17). Differences between studies may be related to the heterogeneous distribution of fat and the rate of accumulation of cardiotoxic metabolites. In parallel with most centers, our opinion is that WC measurement is more reliable than BMI as a diagnostic parameter for MS. In our study, we found that the incidence



Hemorrhage	non-POAF	POAF	p
Unavailable	573	157	
Available	22	4	0,454
Total	595	161	

Stroke	non-POAF	POAF	p
Unavailab	584	138	
Available	11	23	0,001
Total	595	161	

Infection	non-POAF	POAF	p
unavailab	553	145	
available	42	16	0,223
Total	595	161	

Mortality	non-POAF	POAF	p
Unavailab	581	158	
Available	14	3	0,494
Total	595	161	

Graph-4. Graphical analysis of the effect of POAF on postoperative complications. POAF only affected the stroke rate significantly of POAF was affected by obesity by 1,65-fold while by MS by 2,46-fold Graph-1 and 6).

In MS, endothelial dysfunction develops before clinical symptoms occur (18). This may contribute to a view that endothelial dysfunction plays a role in the development of POAF in MS. Almassi et al reported 2-fold higher hospital mortality (3% versus 6%) in post-operative AF cases (19). The 6-month mortality rate was reported to be 4,7% vs 9%. Since the duration of follow up in our study was limited to length of hospitalization, it was not possible to determine the mid and long-term mortality. However, hospital mortality was not significantly different between POAF and Non-POAF cases (2,2%). Mortality of cases diagnosed with MS was found to increase by 2,4 times (Graph-4 and 5) with POAF, whereas by 1,7 times without POAF. POAF also increases postoperative morbidity. In cases with MS, POAF was found to increase the length of the hospitalization by 31%. In our study, we found that MS increased the infection and stroke incidence by 1,9-fold and that the stroke was more severe in patients with POAF.

Geographical region and race were found to be effective in the development of POAF as following regional incidences indicate: Middle East (41,6%), USA (33,7%), Europe (34%), Canada (36,6%), South America (17,4%), Asia (15,7%) (20). This differentiation may be related to the incidence of MS as well as indicating that the white race is more prone to POAF. However, meta-analyses of large series are needed on this subject. In our cases, the incidence of POAF is 21,3% similar to the geographical distribution, while the reported 33% prevalence rate of MS is dissociated (2).

The incidence of AF in the community (0,4-1%) has been reported to increase by age to 8% over the age of 80 (21). In elderly patients, the increase in the rate of POAF is also due to changes in the cardiac fibrosis and atrial dilation (22). In our series, the incidence of POAF increased with age and this increase was 1,9-fold in the 35-55 age group compared to 3,7-fold in the 55-80 age group. We think that besides the degree of atrial fibrosis increasing with age, MS, which is more common in older ages, is also useful on the increase of POAF incidence.

In addition to such preventable causes as surgical dissection, manipulation, pericardial injury, pericarditis, left ventricular dysfunction and atrial dilation due to intraoperative volume overload, electrolyte irregularities, and blood transfusion, techniques for administering the cardioplegia and inadequate atrial cooling could activate the complement system through the oxidative stress-induced release of inflammatory mediators (23). Supporters of this theory argue that the use of anti-inflammatory drugs together with corticosteroids and statins reduces the rate of POAF (10-24). Since all our cases had similar temperatures and durations of CPB, we believe that the effect of such confounding factors on the results was not significant.

It has been reported that 60% of postoperative AF cases have HT (24). Patti et al. Report that HT is an independent risk factor for POAF (25). In our study, the AF rate (27%) in the cases with HT was found to be significant. Hospital mortality in those with HT was twice as high. Blood pressure control can be an essential strategy in preventing AF. We observed that the incidence of stroke was 8,85 times as high in patients with atrial fibrillation. Our treatment strategy was to restore hemodynamic stability, prevent thromboembolism, and eliminate metabolic problems. Choice of anticoagulant treatment for sustaining AF cases was done according to the CHA2DS2VASC scoring system. Guidelines issued by ESC in 2010 recommended the use of the CHA2DS2VASC scoring system (26). By utilizing this scoring system created with large series, the expected risk of thromboembolism is calculated, and the appropriate anticoagulant treatment is determined.

Limitations of the Study

In our study, in cases with obesity and MS, left atrial diameter, a determinant of POAF, was not measured. Left atrial dilation, though an independent risk factor, may be responsible for some of the effects of MS or obesity on POAF. This can be determined by detailed echocardio graphic examination. However, we believe that the interaction is not much since our cases did not have valve problems and the COPD patient count was low.

In the analysis of the effect of clinical factors on the POAF in the 18-35 age group, the absence of association may be due to the low number of samples in the group. Patients with MS and obesity were hospitalized longer. This may lead to prejudice that the capture rate of the POAF could have been affected.

Conclusion

In our study, being more frequent in cases with obesity, hypertension, diabetes mellitus, metabolic syndrome, and older ages, postop atrial fibrillation was found to significantly increase the length of hospitalization. The incidence of the POAF was lower in cases using beta-blockers. Although AF was lower in patients with a beta-blocker, it was not significant. In POAF cases, stroke was 8,85 times more. POAF was found to be positively correlated with WC and BMI measurements. Obesity was found to be one of the critical risk factors of POAF independent of MS.

Metabolic syndrome and obesity are important factors that decrease the quality of life by increasing the incidence of POAF after coronary bypass surgery. If the causes and pathological mechanisms underlying POAF are determined we believe that an appropriate treatment will reduce hospital costs and morbidity in planned cardiovascular interventions.

Conflict of Interests

None of the authors has a conflict of interest with the submission.

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Abbreviations

MS Metabolic Syndrome
AO Abdominal Obesity
HDL High-Density Lipoprotein
LDL Low-Density Lipoprotein
POAF Postoperative Atrial Fibrillation
AF Atrial Fibrillation
CABG Coronary Artery Bypass Grafting
BMI Body Mass Index
HT Hypertension
CPB Cardiopulmonary Bypass
COPD Chronic Obstructive Pulmonary Disease
WC Waist Circumference
DM Diabetes Mellitus
TG Triglyceride
LVEF Left Ventricular Ejection Fraction
IABP Intraaortic Balloon Pomp
MI Myocardial Infarction
ICU Intensive Care Unite
ECG Electrocardiography
ACE Angiotensin Converting Enzyme Inhibitor
CCT Cross Clamp Time

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