RESEARCH ARTICLE

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Gender Differences in Periprocedural and Long-term Outcomes in Patients with Hypertrophic Cardiomyopathy Treated with Alcohol Septal Ablation Therapy: A Single Center Retrospective Study

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Abstract

Background and Aim: We aim to demonstrate the periprocedural and long-term results of alcohol septal ablation (ASA) treatment in patients with hypertrophic cardiomyopathy (HCM) and specify the differences between female and male patients.

Materials and Methods: We enrolled 53 consecutive patients with HCM who underwent ASA treatment. Preprocedural demographic data, pre- and postprocedural characteristics and complications, echocardiographic data, and long-term results, including all-cause mortality and major adverse cardiovascular events (MACE), were recorded. MACE was defined as sudden cardiac death due to ventricular arrhythmias or heart failure (HF) and rehospitalizations due to HF or atrial fibrillation after the procedure.

Results: The mean age was 56.4 ± 12.1 years and 29 (54.7%) of the patients were female. Age at the time of ablation was higher ($P = 0.04$), and the presentation New York Heart Association functional class ($P = 0.03$) was worse in female patients. The median volume of ethanol usage was higher in male patients ($P = 0.03$) and the median duration of intensive care unit stay was higher in female patients ($P = 0.02$). The overall survival rates after ASA at 1, 5, 10, and 12 years were 96%, 87%, 76%, and 76%, respectively. There was no difference in the overall survival rates between genders (log-rank $P = 0.4$) and MACE was significantly higher in women patients (log-rank $P = 0.03$).

Conclusion: Women patients with HCM were older and had a worse functional capacity during the ASA procedure. Despite the similar mortality rates between genders, MACE was higher in women after the procedure. Earlier evaluation and treatment in female patients might decrease MACE during follow-up after ASA treatment.

Keywords: Gender differences, sex differences, hypertrophic cardiomyopathy, alcohol septal ablation, mortality, major adverse cardiovascular events

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INTRODUCTION

Hypertrophic cardiomyopathy (HCM) is one of the most prevalent hereditary cardiac disorders characterized by left ventricular outflow tract (LVOT) obstruction.[1] First-line therapy for reducing LVOT obstruction is medical treatment with negative inotropic drugs. In patients who are resistant to medical treatment, the recommended strategy to relieve LVOT obstruction is septal reduction therapy with surgical septal myectomy or alcohol septal ablation (ASA) therapy.[2,3]

A recent meta-analysis demonstrated that both surgical septal myectomy and ASA procedures have identical short-term and long-term risks for stroke, sudden cardiac death (SCD), all-cause, and cardiovascular (CV) mortality. However, compared with surgical septal myectomy, the ASA procedure is linked with a reduced risk of periprocedural complications but an increased risk of pacemaker implantations and repeated interventions.[4]

Evidence on differences in short- and long-term outcomes after ASA procedures between male and female patients is limited in the literature. women patients with HCM presented in later stages of the disease than men and had more refractory heart failure (HF) symptoms. However, there are inconsistencies about the overall survival between genders.[5] Some studies have demonstrated worse long-term outcomes after ASA in women[6], whereas after propensity score matching analysis of the Euro-ASA Registry, women and men had similar short- and mid-term outcomes after ASA treatment.[7]

Therefore, in this study, we aim to demonstrate the discrepancies in the periprocedural and long-term results of the ASA procedure between female and male patients and specify the differences in major adverse cardiovascular events (MACE) between genders after ASA treatment.

MATERIALS AND METHODS

Study population

We retrospectively enrolled 56 consecutive patients with HCM who underwent ASA procedure due to symptomatic LVOT obstruction despite maximally tolerated medical treatment between January 2010-December 2022. Inclusion criteria were; 1) interventricular septum (IVS) thickness 15 mm; 2) resting or provoked LVOT gradient 50 mmHg, and 3) New York Heart Association (NYHA) functional class II despite optimal medical therapy (OMT).[2,3] The mitral valve abnormalities requiring surgical intervention or any other indication for cardiac surgery were excluded from the study. Informed consent was obtained from all subjects before the procedure. The study protocol was approved by the Dokuz Eylül University Non-invasive Research Ethics Committee (approval number: 2022/33-08, date: 19.10.2022).

Data collection

Institutional electronic medical records were analyzed for data collection. Preprocedural baseline patient characteristics, symptomatic status, comorbidities, medical therapies, and echocardiographic and electrocardiographic (ECG) data were recorded. Postprocedural data including ECG, echocardiographic parameters, and symptomatic status were documented. Mortality data were obtained from death certificates and causes of mortality were noted. MACE was defined as SCD because of ventricular arrhythmias or HF and rehospitalizations due to HF or AF after the procedure.

Alcohol septal ablation

Standard diagnostic coronary angiography was performed for all subjects to determine the coronary heart disease that may need coronary bypass surgery and to assess the appropriateness of the septal perforator artery for an ASA procedure. All procedures were conducted under local anesthesia. A temporary pacemaker was inserted via the femoral vein before the procedure except for patients who had a previously implanted permanent cardiac pacemaker. A pigtail catheter and a 7 French (F) left coronary guiding catheter were inserted via two different femoral arteries. The pigtail catheter was used for measuring the outflow gradient before and after the procedure. After the identification of the septal perforator artery supplying the obstructing part of the septum, it is cannulated by a 0.014-inch guidewire. Afterwards, an over-the-wire (OTW) balloon is advanced into this target septal artery. The OTW balloon is inflated to isolate the septal artery from the other coronary arteries. Radiographic contrast was injected through the OTW balloon to exclude backflow into the left anterior descending (LAD) artery and to opacify the septum area involved in the systolic anterior motion (SAM) contact point. Continuous echocardiographic screening was performed to document the opacification of the septum. Under continuous ECG, echocardiographic, fluoroscopic, and hemodynamic monitoring, a small volume (1-3 mL) of absolute alcohol was injected slowly through the balloon catheter. Balloon occlusion was maintained for at least 10 min. After deflating the OTW balloon, a coronary angiogram was performed to establish complete occlusion of the septal perforator artery and to confirm normal flow in the LAD artery. Transthoracic echocardiography (TTE) and left heart catheterization via a pigtail catheter were used for measuring the LVOT gradient during and after the procedure.

Follow-up

Patients stayed in the coronary intensive care unit (ICU) and were observed carefully for a minimum of 24 h after the intervention. TTE and ECG were performed immediately after the procedure to check for pericardial effusion and complete

heart block (CHB). Cardiac markers (creatinine kinase-myocardial band) and troponin T were measured every 8 h on the first day and daily thereafter until discharge. If a CHB was absent, the temporary pacemaker was removed after 24 h.

Statistical analysis

A statistical software (SPSS version 26; SPSS, Inc., Chicago, IL) was used. The normality of continuous variables was checked with histograms and the Kolmogorov-Smirnov test. The categorical data were presented as numbers and percentages, and continuous data were presented as means standard deviations and median (interquartile range). Pre- and post-treatment echocardiographic data were evaluated with the Paired t-test and Wilcoxon test for continuous data and McNemar tests for categorical data. Survival estimates were calculated using the Kaplan-Meier method. MACE and survival comparisons between genders were made using the log-rank test. A *P*-value of <0.05 was considered significant.

RESULTS

Patient population

ASA could not be performed in three patients because of procedural reasons. The reasons were as follows; septal artery perforation, unable to advance the OTW balloon into the target septal artery, and septal artery tortuosity. After excluding these patients, 53 patients were analyzed. The baseline characteristics of all subjects and the differences in demographics between genders are outlined in Table 1. The mean age of the entire cohort was 56.4 ± 12.1 years and 29 (54.7%) of the patients were female. All subjects were symptomatic despite OMT, including beta-blockers (88.7%) and calcium channel blockers (15.1%). The majority of patients were in sinus rhythm (88.7%) and conduction abnormalities were noted in 3 (5.7%) patients, including left bundle branch block (LBBB) and right bundle branch block (RBBB). None of the patients had a history of surgical myectomy. Four patients (7.5%) had previous coronary revascularization via percutaneous coronary intervention, and none had a history of prior coronary artery bypass surgery. Two patients (3.8%) had a history of ICD implantation and one patient (1.9%) had a history of permanent pacemaker implantation. Age at the time of ablation was higher (59.5 ± 12.3 vs 52.7 ± 10.8, $P = 0.04$), and the presentation NYHA functional class ($P = 0.03$) was worse in female patients (Table 1). Additionally, the percentage of furosemide usage among women was higher than among male patients ($P = 0.04$).

Procedural characteristics

The ASA procedure was performed on 53 patients. There was no procedural death. ASA reduced the resting LVOT gradient from 85 (70-109) to 20 (10-40) mmHg in the overall cohort ($P < 0.001$) (Figure 1). Additionally, the reduction in resting LVOT gradients was comparable between women and men [83 (70-115) to 20 (10-40) in women vs 85 (66-100) to 20 (15-40), $P < 0.001$ for both] (Figure 2). The median volume of ethanol injected was 1.6 (1.1-2.0, interquartile range) mL (Table 2). Intraprocedural CHB was observed in 18 (34%) patients and intraprocedural ventricular arrhythmia was observed in 1 (1.9%) patient (Table 2). In one patient (1.9%), left main coronary artery dissection was observed and treated with successful percutaneous stent implantation during the procedure. Among procedural characteristics, only the median volume of ethanol usage was higher in male patients [2.0 (1.5-2.0) vs 1.5 (1.0-2.0), $P = 0.03$].

Post-procedural characteristics

Post-procedure serum troponin I level peaked at 24.7 (12.1-31.9) ng/mL x 1000 (Table 2). Patients were routinely monitored in the cardiac ICU for 59 (48-96) hours with a total median duration of hospital stay of 7 (6-8) days. Persistent or recurrent CHB was observed in 10 (18.9%) patients and 6 (11.3%) patients required internal cardioverter defibrillator (ICD) implantation before discharge. Post-procedural pericardial effusion was observed in 3 (5.7%) patients, however, there was no cardiac tamponade. Femoral vascular

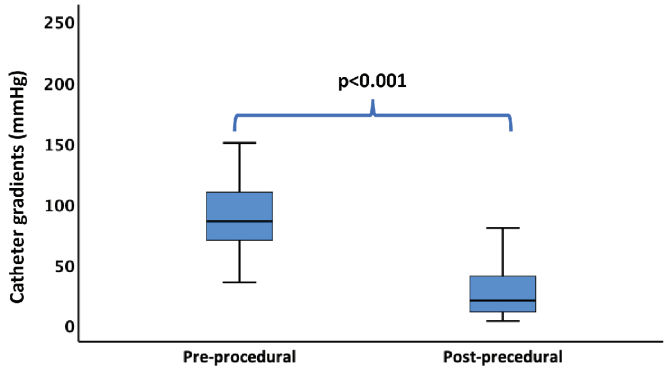

Figure 1: Comparison of pre-and post-procedural gradients

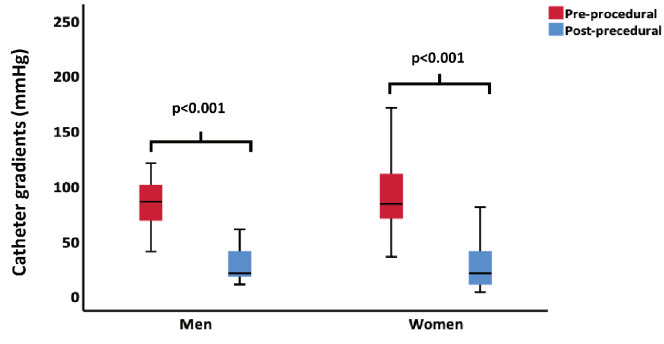

Figure 2: Comparison of pre-and post-procedural gradients in women and men

complications such as hematoma were in 4 (7.5%) patients, and no pseudoaneurysm was noted. The administration of erythrocyte suspension was needed in 3 (5.7%) patients. Post-procedure LBBB was present in 3 (5.7%) patients, RBBB was present in 16 (30.2%) patients, and left anterior fascicular block (LAFB) was present in 8 (15.1) patients (Table 2). Among post-procedural characteristics, the median duration of ICU stay was higher in female patients (p=0.02) (Table 2). Although not statistically significant, most other post-procedural complications were more prevalent in female patients (Table 2). The presence of post-procedural LBBB, RBBB, and LAFB were comparable between women and men.

Two (3.8%) patients died during the hospital stay. One patient died 3 days after the procedure of acute renal failure secondary to CHB. One patient died 29 days after the procedure because of septic shock.

Echocardiographic data

The comparison of pre- and postprocedural echocardiographic data of the female and male patients is presented in Table 3. Echocardiographic was examined one month after the procedure. Left ventricular (LV) end-diastolic diameter (38.8 ± 4.9 to 40.2 ± 4.6, $P = 0.005$) and LV end-systolic diameter (22.6 ± 4.2 to 24.3 ± 3.3, $P = 0.03$) were significantly increased in women after the procedure; however, there was no difference in LV diameters in men after the procedure ($P > 0.05$ for all). IVS diameter (20.9 ± 2.8 to 20.4 ± 3.5, $P = 0.11$ for women and 22.8 ± 3.6 to 21.3 ± 3.4, $P = 0.01$ for men) was only reduced in men; however, resting LVOT gradient [100 (69-132) to 32 (18-70), $P < 0.001$ for women and 77 (58-103) to 30 (21-75), $P < 0.001$ for men] was significantly reduced in both genders. The percentage of SAM was also significantly reduced in both women and men after the procedure ($P = 0.02$ for both).

Table 1: The baseline characteristics of all patients and the difference in demographics between genders

	All patients (*n*=53)	Women (*n*=29)	Men (*n*=24)	*P*-value
Age at the time of ablation* (years)	56.4±12.1	59.5±12.3	52.7±10.8	0.04
NYHA functional class, *n* (%)				0.03
Class II	8 (15.1)	0 (0)	8 (33.3)	-
Class III	41 (77.4)	26 (89.7)	15 (62.5)	-
Class IV	4 (7.5)	3 (10.3)	1 (4.2)	-
Angina, *n* (%)	21 (39.6)	12 (41.4)	9 (37.5)	0.7
Syncope, *n* (%)	18 (34)	8 (27.6)	10 (41.7)	0.3
The family history of SCD, *n* (%)	20 (37.7)	8 (27.6)	12 (50)	0.09
Preoperative non-sustained VT, *n* (%)	16 (30.2)	9 (31)	7 (29.2)	0.8
ECG, *n* (%)				
Sinus rhythms	47 (88.7)	25 (86.2)	22 (91.7)	0.5
AF	6 (11.3)	4 (13.8)	2 (8.3)	NA
LBBB	2 (3.8)	1 (3.4)	1 (4.2)	NA
RBBB	1 (1.9)	1 (3.4)	0 (0)	NA
Hypertension, *n* (%)	20 (37.7)	14 (48.3)	6 (25)	0.08
Diabetes mellitus, *n* (%)	8 (15.1)	6 (20.7)	2 (8.3)	NA
Hyperlipidemia, *n* (%)	13 (24.5)	7 (24.1)	6 (25)	0.9
Prior coronary revascularization, *n* (%)	4 (7.5)	1 (3.4)	3 (12.5)	NA
Prior stroke, *n* (%)	2 (3.8)	0 (0)	2 (8.3)	NA
ICD, *n* (%)	2 (3.8)	1 (3.4)	1 (4.2)	0.9
The permanent pacemaker, *n* (%)	1 (1.9)	1 (3.4)	0 (0)	NA
Medications, *n* (%)				
Beta blocker	47 (88.7)	25 (86.2)	22 (91.7)	0.5
Calcium channel blocker	8 (15.1)	6 (20.7)	2 (8.3)	NA
ACEI/ARB	10 (18.9)	6 (20.7)	4 (16.7)	0.7
Furosemid	8 (15.1)	7 (24.1)	1 (4.2)	0.04
Spironolacton	2 (3.8)	2 (6.9)	0 (0)	NA
Amiodarone	11 (20.8)	4 (13.8)	7 (29.2)	0.17

*Mean ± standard deviation. NHYA: New York Heart Association, SCD: Sudden cardiac death, ECG: Electrocardiography, AF: Atrial fibrillation, LBBB: Left bundle branch block, RBBB: Right bundle branch block, ICD: Internal cardioverter defibrillator, ACEI: Angiotensin-converting enzyme inhibitors, ARB: Angiotensin receptor blockers, VT: Ventricular tachycardia, NA: Non-applicable

Accordingly, mitral regurgitation severity was also decreased after the procedure for both genders (P = 0.004 for women, and P < 0.001 for men) (Table 3).

Clinical outcomes

The mean follow-up period was 12.7 ± 3.3 years. There was no repeated ASA procedure in the overall cohort. Three (5.4%) patients required surgical myectomy, and among these patients, 2 of them also required mitral valve replacement. ICD implantation after discharge was noted in 4 (7.5%) patients. The mean NYHA functional class decreased from 2.7 0.5 to 1.9 0.6 in men (P < 0.001) and 3.1 0.3 to 2.0 0.6 in women (P < 0.001) after the procedure. Seven (13.2%, 4 female and 3 male) patients died after hospital discharge. Three of 7 deaths were due to CV causes. A detailed description of the causes of death is outlined in Table 4. MACE was observed in 13 (24.5%) patients. The overall survival rates after the ASA procedure at 1, 5 and

Table 2: Procedural and post-procedural characteristics of all patients and comparison between genders

	All patients (*n*=53)	Women (*n*=29)	Men (*n*=24)	*P*-value
Procedural characteristics				
Pre-procedural gradient† (mmHg)	85 (70-109)	83 (70-115)	85 (66-100)	0.7
Post-procedural gradient† (mmHg)	20 (10-40)	20 (10-40)	20 (15-40)	0.48
The volume of ethanol† (mL)	1.6 (1.1-2.0)	1.5 (1.0-2.0)	2.0 (1.5-2.0)	0.03
Intraprocedural CHB, *n* (%)	18 (34)	11 (37.9)	7 (29.2)	0.15
Intraprocedural VT/VF, *n* (%)	1 (1.9)	1 (3.4)	0 (0)	NA
Post-procedural characteristics				
Persistent/recurrent CHB, *n* (%)	10 (18.9)	8 (27.6)	2 (8.3)	0.07
Pericardial effusion, *n* (%)	3 (5.7)	3 (10.3)	0 (0)	NA
Hematoma, *n* (%)	4 (7.5)	4 (13.8)	0 (0)	NA
The administration of ES, *n* (%)	3 (5.7)	2 (6.9)	1 (4.2)	0.67
LBBB, *n* (%)	3 (5.7)	2 (6.9)	1 (4.2)	0.67
RBBB, *n* (%)	16 (30.2)	9 (31)	7 (29.2)	0.8
LAFB, *n* (%)	8 (15.1)	4 (13.8)	4 (16.7)	0.7
Peak troponin I† (ng/mLx1000)	24.7 (12.1-31.9)	20 (10.3-28.3)	26.2 (14.3-45)	0.22
ICU stay† (hours)	59 (48-96)	72 (50-120)	48 (40-72)	0.02
Hospital stay† (days)	7 (6-8)	7 (6-8.5)	7 (4-8)	0.8
ICD before discharge, *n* (%)	6 (11.3)	4 (13.8)	2 (8.3)	0.5

†Median (interquartile range). CHB: Complete heart block, VT: Ventricular tachycardia, VF: Ventricular fibrillation, LBBB: Left bundle branch block, RBBB: Right bundle branch block, LAFB: Left anterior fascicular block, ICU: Intensive care unit, ICD: Intracardiac cardioverter defibrillator, NA: Non-applicable

Table 3: Comparison of pre- and postprocedural echocardiographic data of male and female patients

	Women (*n*=29)			Men (*n*=24)		
	Pre-procedural	Post-procedural	*P*-value	Pre-procedural	Post-procedural	*P*-value
LVEDD* (mm)	38.8±4.9	40.2±4.6	0.005	39.5±4.5	41.6±5.5	0.35
LVESD * (mm)	22.6±4.2	24.3±3.3	0.03	22.1±2.9	25.3±4.9	0.6
LA* (mm)	45.1±5.5	43.8±4.9	0.2	44.9±5.4	45.5±5.6	0.28
LVEF† (%)	64 (60-66)	60 (60-65)	0.08	65 (60-68)	60 (60-65)	0.07
IVS* (mm)	20.9±2.8	20.4±3.5	0.11	22.8±3.6	21.3±3.4	0.01
Resting LVOT gradient† (mmHg)	100 (69-132)	32 (18-70)	<0.001	77 (58-103)	30 (21-75)	<0.001
SAM, *n* (%)	27 (93.1)	16 (55.2)	0.02	20 (83.3)	13 (54.2)	0.02
MR, *n* (%)			0.004			<0.001
Mild	9 (31)	18 (62.1)		13 (54.2)	17 (70.8)	
Moderate	11 (37.9)	7 (24.1)		6 (25)	3 (12.5)	
Severe	9 (31)	4 (13.8)		5 (20.8)	4 (16.7)	

*Mean ± standard deviation, †Median (interquartile range). LVEDD: Left ventricular end-diastolic diameter, LVESD: Left ventricular end-systolic diameter, LA: Left atrium, LVEF: Left ventricular ejection fraction, IVS: Interventricular septum, LVOT: Left ventricular outflow tract, SAM: Systolic anterior motion, MR: Mitral regurgitation

12 years were 96%, 87%, 76%, and 76%, respectively (Figure 3). There was no difference in the overall survival rates between male and female patients (log-rank $P = 0.4$) (Figure 3). However, the cumulative incidence of MACE in women was significantly higher than in male patients (log-rank $P = 0.03$) (Figure 4).

DISCUSSION

Our results demonstrated that age at the time of ablation was higher and the presentation NYHA functional class was worse in female patients. The volume of ethanol usage was higher in male patients, whereas the duration of ICU stay after ASA was higher in female patients. Post-procedural increases in LV diameters were more prominent in female patients, however, the decrease in IVS thickness was more prominent in male patients. Our results also demonstrated that the overall survival rates after the ASA procedure at 1, 5, 10, and 12 years were 96%, 87%, 76%, and 76%, respectively. There was no difference in overall survival rates between male and female patients, however, the cumulative incidence of MACE in women patients was significantly higher than in male patients.

Our results are consistent with preexisting reports in terms of late presentation and worse clinical profiles in female patients.[5] This was partially explained by the protective effects of estrogens in women's hearts. Various animal models have shown that the female heart has a greater hypertrophic reserve and the transition to HF was quicker in male hearts in pressure-overloaded rat models.[8] Additionally, it is obvious that all CV diseases are underdiagnosed, under-treated, and under-recognized in female patients globally.[9] The women's access

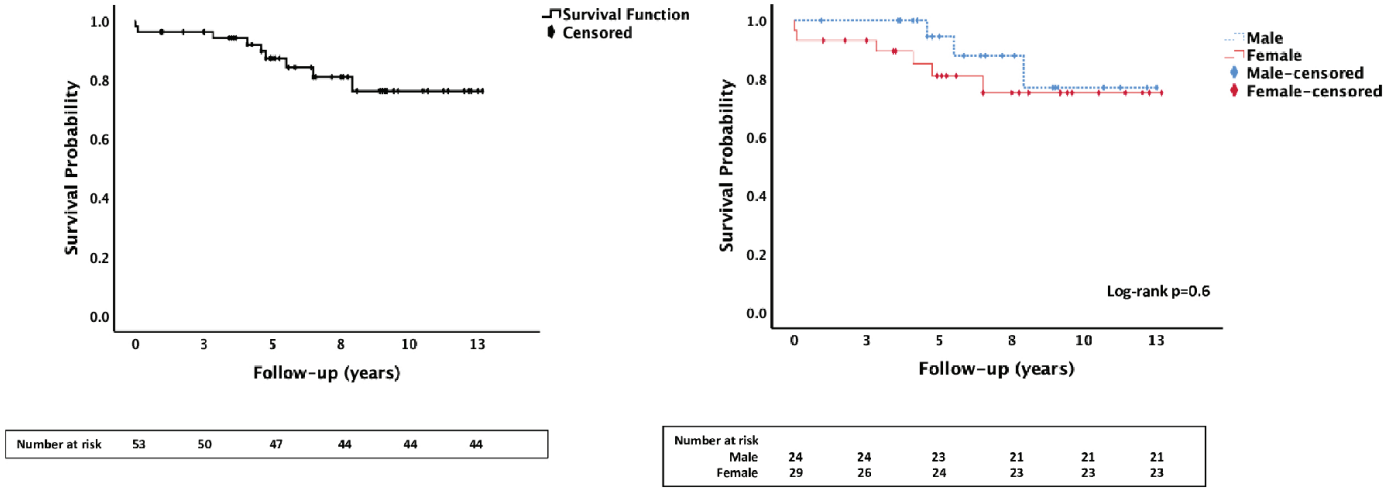

Figure 3: Kaplan-Meier survival curves for all-cause mortality in all patients and difference between female and male patients

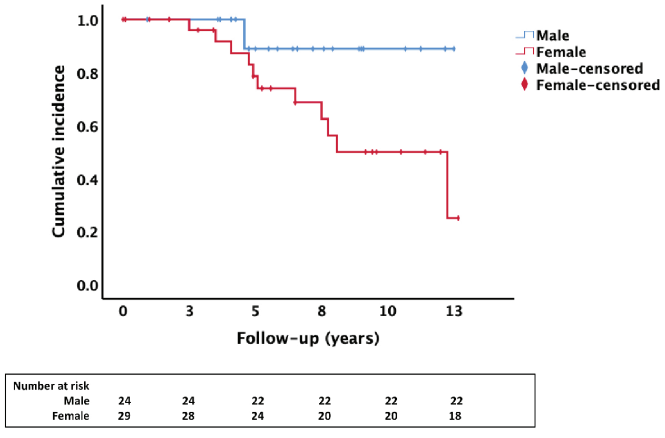

Figure 4: Kaplan-Meier cumulative incidence curves for MACE in female and male patients

MACE: Major adverse cardiovascular events

Table 4: A detailed description of causes of death after hospital discharge

Age (years)	Gender	Cause of death
51	Female	Acute respiratory distress syndrome secondary to SARS-CoV-2
56	Female	Sudden cardiac death secondary to ventricular fibrillation
69	Male	Heart failure
65	Male	Acute respiratory distress syndrome secondary to SARS-CoV2
72	Female	Heart failure
74	Female	Septic shock
59	Male	Respiratory failure secondary to amyotrophic lateral sclerosis

SARS-CoV2: Severe acute respiratory syndrome coronavirus-2

to optimal health care was limited because of socioeconomic and sociocultural factors, resulting in late presentation and treatment in female patients.

We showed that the increase in LV diameters after the ASA procedure was statistically significant in women, however, we were unable to show this effect in men patients. Contrary to our findings, Chen et al.[10] demonstrated that reverse remodeling after ASA was greater in men than in women. They have also shown that the main predictor of LV reverse remodeling was a change in the LVOT gradient. In our study, the magnitude of change in the LVOT gradient was higher in women [100 (69-132) to 32 (18-70) vs 77 (58-103) to 30 (21-75)] than in men, which might have resulted in a more prominent increase in LV diameters in female patients. We also showed that the decrease in IVS thickness was more prominent in male patients. The greater volume of ethanol usage in male patients might have resulted in this observation as higher doses of ethanol have resulted in more decrease in IVS diameter.[11]

Several single-center and national ASA registries establish the short- and long-term results of the ASA procedure in the literature.[12-16] Our results were comparable with large registries including the EURO-ASA registry which demonstrated a 10-year survival rate of 77%[15] and the North American ASA registry which demonstrated a 9-year survival rate of 74%.[12] Contrary to our findings, the largest single-center study from our country showed a 10-year survival rate of 85%.[16] The main difference between these two studies from Turkey was the higher pre-discharge median LVOT gradient after the ASA procedure in our study [32 (18-70) in women and 30 (21-75) in men vs 21 (10-33) in women and 21 (11-32) in men]. EURO-ASA registry demonstrated that each mmHg elevation in LVOT gradient after the procedure resulted in ~1% increase in overall mortality.[15] The higher mean residual LVOT gradient in our study might have resulted in this discrepant result.

The overall survival rates after ASA treatment was similar between genders in our cohort. Our results were comparable with the large Euro-ASA registry[7], which demonstrated similar outcomes between male and female patients. We also showed that the cumulative incidence of MACE in women was significantly higher than in male patients. Similar to our findings, female sex was found to be the only significant predictor of MACE related to HCMP.[17] This may be explained by several reasons. First, the smaller LV cavity and higher residual LVOT gradient in female patients might have resulted in a higher incidence of HF hospitalizations.[18,19] Second, women had a poor diastolic reserve and higher LV filling pressures, which might have resulted in a higher incidence of HF with preserved ejection fraction in women.[20] Finally, NYHA functional class was found to be a significant predictor of AF in HCMP.[21] The worse NYHA functional class in female patients might have resulted in more frequent AF in our study.

Study limitations

The major limitation of our study was the small size of the cohort. Additionally, it has limitations specific to retrospective analyzes the lack of assessment of CV mortality is another important limitation. We could not assess whether there was a difference in CV mortality after the ASA procedure between genders. The fact that the medical treatments received by the patients after the procedure were not evaluated may have affected the results regarding MACE.

CONCLUSION

Women presented at a later age and had a worse NYHA functional capacity before the ASA procedure. There was no difference in all-cause mortality between genders, but the cumulative incidence of MACE was higher in women after the procedure. Earlier evaluation of female patients with HCMP for ASA procedure might have resulted in fewer MACEs during follow-up.

Ethics

Ethics Committee Approval: The study protocol was approved by the Dokuz Eylül University Non-invasive Research Ethics Committee (approval number: 2022/33-08, date: 19.10.2022).

Informed Consent: Informed consent was obtained from all subjects before the procedure.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: H.D., B.A., N.B., Ö.B., Ö.G., Concept: A.Ç., Design: A.Ç., E.Ö., Data Collection or Processing: A.A.B., Z.K., Analysis or Interpretation: A.Ç., E.Ö., Literature Search: A.Ç., Z.K., Writing: A.Ç.

Conflict of Interest: No conflict of interest was declared by the authors.

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