Perioperative and mid-term outcomes of mitral valve surgery with and without concomitant surgical ablation for atrial fibrillation: a retrospective analysis

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Visual Abstract

Descriptive Title: Surgical ablation for atrial fibrillation in mitral valve surgery

Summary: In a retrospective study of 400 patients who underwent mitral valve surgery, we compared patients with and without atrial fibrillation by evaluating the impact of surgical ablation. The results showed that concomitant surgical ablation for atrial fibrillation yields comparable mid-term outcomes to those of patients without preoperative atrial fibrillation.

Legend: freedom from composite adverse events (death, stroke, major bleeding)

Abstract

Objectives: We retrospectively analyzed perioperative and mid-term outcome for patients undergoing mitral valve surgery with and without atrial fibrillation.

Method: Patients who underwent mitral valve surgery between January 2018 and February 2023 were included and categorized into three groups: "No AF" (no documented atrial fibrillation), "AF no SA" (atrial fibrillation without surgical ablation), and "AF and SA" (atrial fibrillation with concomitant surgical ablation). Groups were compared for perioperative and mid-term outcomes, including mortality, stroke, bleeding and pacemaker implantation. A p-value < 0.05 was considered statistically significant.

Results: Of the 400 patients included, preoperative atrial fibrillation was present in 43%. Mean follow-up was 1.8 (SD: 1.1) years. The patients who underwent surgical ablation for atrial fibrillation exhibited similar overall outcomes compared to patients without preoperative atrial fibrillation. Patients with untreated atrial fibrillation showed higher mortality (“No AF”: 2.2% vs “AF no SA”: 8.3% vs “AF and SA”: 3.2%; p-value 0.027) and increased postoperative pacemaker implantation rates (“No AF”: 5.7% vs “AF no SA”: 15.6% vs “AF and SA”: 7.9%, p-value: 0.011). In a composite analysis of adverse events (Mortality, Bleeding, Stroke), the highest incidence was observed in patients with untreated atrial fibrillation, while patients with treated atrial fibrillation had similar outcomes as those without preoperative documented atrial fibrillation (“No AF”: 9.6% vs “AF no SA”: 20.2% vs “AF and SA” 3: 9.5%, p-value: 0.018).

Conclusion: Concomitant surgical ablation should be considered in mitral valve surgery for atrial fibrillation, as it leads to similar mid-term outcomes compared to patients without preoperative documented atrial fibrillation.

Keywords

Atrial fibrillation, surgical ablation, mitral valve, cardiac surgery

ABBREVIATIONS

AF	Atrial fibrillation
SD	Standard deviation
MVS	Mitral valve surgery
SA	Surgical ablation
LAA	Left atrial appendage

Introduction

Atrial fibrillation (AF) affects an estimated 2.8% of the general population (1). Among patients undergoing cardiac surgery, the incidence of preoperative AF reaches up to 10%, with a higher occurrence among patients presenting for mitral valve surgery (30–60%) (2-5). Patients with AF have reduced survival compared to those in sinus rhythm (1), with increased rates of stroke, heart failure, and all-cause mortality (6). Surgical ablation of AF effectively restores sinus rhythm (7,8,9), and some studies have reported significantly better survival in patients undergoing surgical ablation (10-12). Current ESC/EACTS guidelines recommend concomitant AF ablation for all patients with a history of AF (Class IIa recommendation, Level A) (13). This study aims to analyze the survival and surgical outcomes of patients with AF undergoing mitral valve surgery.

Methods

Ethics Statement

The initiation of a mitral valve registry complied with the Declaration of Helsinki and was approved by the local ethics committee on the 28th of September 2017 (BASEC number 2017-01104). All patients provided written informed consent for participation.

Population and study design

This retrospective analysis included consecutive patients over 18 years of age who underwent mitral valve surgery (MVS) at Inselspital, Bern University Hospital, from June 2018 to February 2023. Patients with endocarditis were excluded. Patients were categorized into 3 groups :

i) patients undergoing MVS without documented preoperative AF (No AF),

ii) patients undergoing MVS with documented preoperative AF not undergoing SA (AF no SA), and

iii) patients with preoperative AF undergoing MVS with concomitant SA (AF and SA).

These groups were compared for perioperative and mid-term outcomes, including mortality, stroke, bleeding and pacemaker implantation.

Surgical procedure

Patients underwent either mitral valve repair or replacement according to current guidelines. Concomitant left or biatrial ablation, including "box lesions", pulmonary vein isolation and an exclusion line to the mitral annulus was performed using cryoablation or radiofrequency.

If a right-sided ablation was performed, the right atrial incision was made and prolonged down to the crista terminalis. Then the ablation lines were placed using the cryoprobe in the lateral superior vena cava, inferior vena cava, and the anterior tricuspid annulus. In case of AF, if possible, a left atrial appendage exclusion with either suture or AtriClip was performed. The decision whether to perform the ablation procedure or a left atrial appendage exclusion was at surgeon discretion.

Data collection

Demographic and echocardiographic data were collected prospectively. Follow-up data until 3 years were gathered at discharge, 30 days, 1 year, and 3 years through direct contact, physician documentation, and hospital records. The primary endpoint was all-cause mortality within the follow-up period. Secondary endpoints included cerebrovascular accidents (defined by neurological deficit lasting >24h, or <24h if available neuroimaging documents a new hemorrhage or infarct), postoperative permanent pacemaker implantation, bleeding requiring surgical revision, and postoperative detection of AF or atrial flutter.

Postoperative management

Postoperative anticoagulation

Patients with mechanical mitral valves received lifelong coumarin therapy (INR 2.5-3.5). Those with biological mitral valves or mitral valve repair received 3 months of coumarin therapy (INR 2-3). As from June 2022, we changed the protocol for patients undergoing mitral valve repair, and the coumarin therapy was substituted with new oral anticoagulants. After 3 months anticoagulation was stopped if there was no further indication.

Postablation pacing strategy und medical therapy

Patients in sinus rhythm received 72 hours of atrial pacing (90-100 bpm), followed by beta-blockers if needed. No routine rhythm control therapy was performed. Anticoagulation continued for at least 3 months post-ablation. The family physician or cardiologist decided whether or not to continue the anticoagulation 3 months after surgery. Generally, we recommend interrupting the anticoagulation therapy only in cases of a CHADS-VASc score of 0 (males) and ≤ 1 (females).

Rhythm Monitoring

Standard electrocardiograms were performed at discharge and during follow-ups at 30 days, 1 year, and 3 years.

Statistical analysis

Discrete variables are presented as numbers, percentages or proportions and compared with either the χ^2 test or the Fisher's exact test, where appropriate. Continuous variables are presented as mean ± standard deviation or median with the interquartile range if there was evidence of non-normal data according to the Kolmogorov–Smirnov test and compared with either the Student's *t*-test or the Wilcoxon rank-sum test, where appropriate.

Cumulative incidences were assessed using Kaplan–Meier curves to estimate the probability of:

(i) cerebrovascular accidents,

(ii) major bleeding

(iii) all cause mortality in the overall cohort.

(iv) postoperative pacemaker implantation

Two-sided p-values <0.05 were considered to be statistically significant. Data analyses were done using R software, version 4.3 (R Foundation, Vienna, Austria).

Results

Patients

After exclusion of patients suffering from endocarditis, the population consisted of 400 patients. The first group (No AF) comprised 228 patients who underwent mitral valve surgery without preoperative documented AF. The second group (AF no SA) included 109 patients with preoperative documented AF who underwent mitral valve surgery without an ablation procedure. In the third group (AF and SA), a total of 63 patients were enrolled. In this group with preoperative documented AF, the patients underwent mitral valve surgery and a surgical ablation procedure. At the time of the analysis, the mean follow-up was 1.8 years (SD: 1.1), and only 3 (0.7%) patients were lost to follow-up.

The baseline characteristics of the cohort differed significantly, as summarized in Table 1. The age varied among the three groups, with Patients suffering from AF who did not undergo SA being older (No AF: 62.6 years (SD: 12.4); AF no SA: 72.7 years (SD: 7.8); AF and SA: 68.9 years (SD: 10.5); p-value <0.001). Comorbidities also differed among the three groups, including type 2 diabetes (No AF: 7.0%; AF no SA: 18.3%; AF and SA: 16.7%; p-value 0.004) and arterial hypertension (No AF: 50.4%; AF no SA: 74.3%; AF and SA: 73.8%; p-value <0.001). The most common type of AF was the paroxysmal type (AF no SA: 49.5%; AF and SA: 47.6%). There was also a difference in left ventricular ejection fraction among the three groups, with patients not suffering from AF showing a higher ejection fraction (No AF: 61% (SD: 10); AF no SA: 58% (SD: 10); AF and SA: 55% (SD: 12); p-value <0.001). In patients suffering from AF who did not undergo surgical ablation, the mean atrial diameter was more than 50 mm (No AF: 45mm (SD: 6); AF no SA: 52mm (SD: 8); AF ad SA: 49mm (SD: 5); p-value <0.001). The EuroSCOREII also differed among the three groups, being higher in the group of patients suffering from AF who did not undergo SA (No AF: 2.8 (SD: 3.4); AF no SA: 6.7 (SD: 7.4); AF and SA: 4.7 (SD: 3.6); p-value <0.001).

Surgical treatment

All the patients in all groups underwent MVS. There was a difference among the groups in terms of incidence of mitral valve replacement (No AF: 38.2%; AF no SA: 68.8%; AF and SA: 44.4%; p-value <0.001). The indication for mitral valve surgery was, in the majority of the cases, due to insufficiency (No AF: 91.3%; AF no SA: 93.6%; AF and SA: 98.4%). Other indications for mitral valve surgery were due to stenosis (No AF: 8.3%; AF no SA: 6.4%; AF and SA: 1.6%) or, in one case in the No AF group, due to fibroelastoma without relevant stenosis or insufficiency. In patients suffering from AF, left atrial appendage (LAA) occlusion was performed significantly more often if a surgical ablation was also performed (LAA-Occlusion: AF no SA: 37.6 % vs AF and SA: 92.1%; p-value <0.001). Concomitant tricuspid valve surgery also differed among the three groups (No AF: 14 % vs AF no SA: 55 %; AF and SA: 49%; p-value < 0.001). Among patients suffering from AF, those who underwent SA showed a lower incidence of permanent AF (AF no SA: 24.8%; AF and SA: 9.5%; p-value 0,025) with an average left atrium size of less than 50 mm (AF no SA: 52 mm (SD: 8); AF and SA: 49 mm (SD: 5); p-value 0.015), a lower rate of previous cardiac surgery (AF no SA: 16.5%; AF and SA: 3.2%; p-value 0.017). Furthermore, although not statistically significant, patients who received SA underwent fewer concomitant procedures during surgery, such as SAVR or CABG (AF no SA: 47.7%; AF and SA: 36.5%; p-value 0.205). Details of the surgical interventions are shown in Table 2.

Survival

The incidence of all-cause mortality in the whole cohort during follow-up was 4% (n=16), with an early mortality (30 days) of 1% (n=4) (No AF: 1.3%, n=3; AF no SA: 0%; n=0; AF and SA: 1.5%, n=1; p-value 0.856). Patients suffering from AF who did not undergo surgical ablation showed the highest overall mortality during follow-up, while similar mortality rates were noted in patients with surgically ablated AF and those without preoperative documented AF (Mortality: No AF: 2.2% vs AF no SA: 8.3% vs AF and SA: 3.2%; p-value 0.03). A Kaplan-Meier curve representing the survival from all cause of mortality is reported in the Figure 1.

Adverse events

Between the three groups, there was no statistically significant difference regarding cerebrovascular accident (No AF: 4.8% vs AF no SA: 8.3% vs AF and SA: 7.9%, p-value: 0.397) and major bleeding (No AF: 3.5% vs AF no SA: 5.5% vs AF and SA: 1.6%, p-value: 0.304). The incidence of postoperative implantation of a permanent pacemaker was higher in patients suffering from AF who did not undergo SA (No AF: 5.7% vs AF no SA: 15.6% vs AF and SA: 7.9%, p-value: 0.01). A Kaplan-Meier curve for postoperative permanent pacemaker implantation is represented in the Figure 2. By analyzing a composite of adverse events, including all cause of mortality, cerebrovascular accidents, and major bleeding, the AF no SA group showed a higher incidence of adverse events. In this analysis of composite outcomes, patients with no preoperative documented AF and patients with AF who underwent concomitant SA show comparable results (No AF: 9.6% vs AF no SA: 20.2% vs AF and SA: 9.5%, p-value: 0.02). A Kaplan-Meier curve representing the freedom from composite adverse events is reported in the Figure 3.

Postoperative AF

The incidence of new onset or recurrent postoperative AF during follow-up was not statistically different between the 3 groups with patients with untreated AF showing the highest incidence of postoperative AF (No AF: 29.8%; AF no SA: 42.2%; AF and SA: 31.7%; p-value 0.37).

Discussion

Concomitant surgical ablation should be considered in mitral valve surgery for AF, as it yields similar mid-term outcomes compared to patients without preoperative documented AF.

Patients

The three groups in this study show different baseline characteristics. Notably, the AF without SA group has a significantly higher EuroSCOREII, suggesting worse outcomes. However, attributing these outcomes solely to the absence of SA for AF would be inaccurate. The baseline characteristics of patients with treated AF and those without preoperative AF are similar, allowing for a nuanced interpretation. While propensity score matching could address this, the small patient pool prevented such analysis to avoid excessive patient loss.

Survival

Consistent with previous studies, patients with untreated AF undergoing cardiac surgery had diminished survival rates compared to those in sinus rhythm (14,15). Our research indicates that MVS patients with simultaneous SA for AF have survival rates comparable to those without a history of AF. Current data on the survival benefits of surgical ablation during cardiac surgery remain controversial even though the ESC/EACTS guidelines recommend concomitant AF ablation in all cardiac surgery patients with AF (Class IIa, Level A) (3,8,13,16-19).

Surgical data and ablation technique

The study found a high mitral valve replacement rate, especially in the untreated AF group, likely due to more frequent concomitant procedures and reoperations. Since 2022, mitral valve reconstruction rates improved to about 90%, possibly due to a more aggressive valve-sparing surgery approach.

The decision to perform SA in cases of AF was not driven by a protocol, but rather was at the surgeon's discretion. As mentioned before, current guidelines recommend SA in cardiac

surgical patients suffering from AF, but they also advise a risk-benefit assessment based on multiple risk factors. Patients with a large left atrium and permanent AF are more likely to experience AF recurrence, and in the case of high-risk surgical patients, the benefit of SA may not be as high as the potential risk of an additional ablation procedure (13).

The results of this study suggest that patients with diagnosed AF who did not undergo SA exhibited one or more of the following characteristics that could have influenced the surgeon's decision: permanent AF, larger LA and previous cardiac surgery. The interpretation of these data must be done carefully, as there are certainly other factors that the surgeon considered in making a decision (e.g., patient's frailty, patient's wishes, etc.). However, it is reasonable to assume that patients with a higher probability of surgical ablation success and lower surgical risk were more likely to receive surgical ablation.

Adverse events

In the recent literature regarding SA in patients with preoperative AF the main focus is the improvement of survival. However, other 'soft' endpoints are of utmost importance as postoperative AF can affect Quality of Life in a major way (21). Therefore, the relevancy of other endpoints, such as the restoration of sinus rhythm, freedom from postoperative stroke, major bleeding and postoperative pacemaker implantation are only parts of the greater puzzle. While we did not observe a significant difference in postoperative stroke among all groups, there was a slightly higher tendency for stroke in patients with AF who did not undergo ablation treatment. With regard to the analysis of stroke, we must point out the difference in the LAA occlusion rate between the AF groups since LAA occlusion has been reported to reduce stroke incidence after cardiac surgery without adding any significant risk of complications (22).

In our cohort LAA occlusion was systematically performed in the ablation group (AF and SA: 92.1 % of LAA occlusion). In the group of patients suffering from AF who did not receive surgical ablation the LAA occlusion rate was only 34.5%. The low LAA occlusion rate in this group can be attributed to the fact that in most cases examined, the results of the LAOS III

study had not yet been published at the time of the surgery. Withlock P.R. et al. demonstrated the benefits of LAA occlusion in patients with AF undergoing cardiac surgery (23). This lower rate of LAA occlusion may have led to a higher incidence of stroke in the non-ablation group. Even in the composite analyses of adverse events (including mortality, major bleeding, and stroke), where the “AF no SA” group exhibits a poorer outcome, this has to be taken in to account. In patients with no preoperative documented AF, 9.6% of patients (n= 22) received isolated LAA occlusion. These patients presented a severe enlarged left atrium with enlarged LAA. In view of the high probability of new postoperative AF the surgeon opted for a preemptive surgical LAA occlusion in these cases.

Some studies indicate a higher risk of pacemaker implantation after surgical ablation (8,24), particularly after biatrial ablation (20). However, in our study, AF patients without SA had the highest pacemaker implantation rates. This may be due to a higher incidence of concomitant surgeries, including tricuspid and aortic valve interventions and mitral valve replacements, as well as more frequent reoperations. A larger left atrium diameter might also have impacted atrioventricular transmission. The No AF and AF with SA groups had similar postoperative pacemaker implantation rates, likely because the Ablation group mostly underwent left atrial ablation, which carries a lower risk for pacemaker implantation (24).

Postoperative AF

In our study, there was no significant difference in new or recurrent postoperative AF among the three groups. Postoperative AF freedom was 57% in AF patients without SA, compared to 10-30% reported in recent studies (8,25). In the SA Group, AF freedom was about 70%, consistent with current literature (8,20). Patients without preoperative AF had a 30% incidence of new postoperative AF, lower than reported for valve surgery patients (26-28). These differences can be explained by the fact that in this study, postoperative rhythm monitoring solely relied on standard ECG, which is insufficient to reliably detect postoperative arrhythmias. More effective monitoring tool such as 14-days Holter ECG or implantation of event recorder have not been routinely used.

Limitations

In addition to all the inherent limitations related to the retrospective nature of this study, it is crucial to recognize several additional limitations present in our conducted analyses. The first concern is the relatively small number of patients with AF, resulting in a very low certainty of evidence due to imprecision. Secondly, due to the limited number of patients, propensity score matching was not performed. This resulted in the formation of groups with significantly different baseline characteristics, especially in the case of the "AF without SA" group. Therefore, results have to be interpreted with caution. An additional limitation is the lack of continuous rhythm control after surgery. The incidence of postoperative onset of AF is likely underestimated, and establishing a direct correlation between rhythm and clinical outcomes was not possible. Despite these limitations, we have synthesized the available body of knowledge to provide valuable insights for clinical decision-making.

Conclusion

In this cohort, MVS with concomitant SA for AF yields similar mid-term outcomes compared to patients without preoperatively documented AF. Furthermore, untreated AF associates with increased mortality and morbidity. Therefore, after a risk-benefit assessment, concomitant SA should be performed in patients undergoing MVS if AF is present.

Conflict of interest

The authors report no conflicts of interest.

Data Availability Statement

The data underlying this article will be shared on reasonable request to the corresponding author.

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Tables

Table 1: Baseline characteristics

	No AF	AF no SA	AF and SA	p-value
n	228	109	63	
Age (mean (SD))	62.61 (12.37)	72.71 (7.81)	68.86 (10.48)	<0.001
Female (%)	74 (32.5)	45 (41.3)	23 (36.5)	0.28
BMI (mean (SD))	25.23 (4.51)	26.28 (4.73)	27.17 (5.83)	0.009
Arterial hypertension (%)	115 (50.4)	81 (74.3)	45 (73.8)	<0.001
Diabetes Typ II (%)	16 (7.0)	20 (18.3)	10 (16.7)	0.004
Dialysis (%)	3 (1.3)	2 (1.9)	1 (1.7)	0.925
Tye of atrial fibrillation (%)				
Paroxysmal		54 (49.5)	30 (47.6)	
Persistent		28 (25.7)	27 (42.9)	
Permanent		27 (24.8)	6 (9.5)	
Previous cardiac surgery (%)	21 (9.2)	18 (16.5)	2 (3.2)	0.015
EuroSCOREII (mean (SD))	2.83 (3.40)	6.76 (7.40)	4.74 (3.64)	<0.001
LVEF (mean (SD))	61.19 (10.47)	57.71 (9.59)	54.63 (12.96)	<0.001
Left atrium diameter (mean (SD))	41.75 (10.19)	52.44 (7.95)	49.47 (5.22)	<0.001
Pacemaker (%)	4 (1.8)	10 (9.2)	1 (1.6)	0.002
Mitral valve regurgitation (%)				0.13
none	2 (0.9)	1 (0.9)	0 (0.0)	
mild	18 (7.9)	6 (5.5)	1 (1.6)	
moderate	16 (7.0)	13 (11.9)	11 (17.5)	
severe	192 (84.2)	89 (81.7)	51 (81.0)	
Tricuspid valve regurgitation (%)				<0.001
none	66 (29.1)	13 (11.9)	6 (9.5)	
mild	140 (61.7)	47 (43.1)	34 (54.0)	
moderate	16 (7.0)	30 (27.5)	17 (27.0)	
severe	5 (2.2)	19 (17.4)	6 (9.5)	

No AF: Patients without preoperative documented AF

AF no SA: Patients with AF without surgical ablation

AF and SA: Patients with AF with surgical ablation

Table 2: Surgical data

Surgical data	No AF	AF no SA	AF and SA	p-value
n	228	109	63	
Mitral valve replacement	87 (38.2)	75 (68.8)	28 (44.4)	<0.001
Surgical ablation (%)			63 (100.0)	
Left atrial appendage occlusion (%)	22 (9.6)	41 (37.6)	58 (92.1)	<0.001
AtriClip (%)	5 (2.2)	31 (28.4)	45 (71.4)	<0.001
Suture (%)	17 (7.5)	10 (9.2)	13 (20.6)	0.008
Tricuspd valve repair (%)	31 (13.6)	59 (54.1)	31 (49.2)	<0.001
Tricuspid valve replacement (%)	1 (0.4)	1 (0.9)	0 (0.0)	0.699
Other concomitant procedures (%)	84 (36.8)	52 (47.7)	23 (36.6)	0.138
Arotic valve replacement (%)	44 (19.3)	29 (26.6)	15 (23.8)	0.296
Coronary artery bypass graft (%)	47 (20.6)	25 (22.9)	12 (19.0)	0.814

No AF: Patients without preoperative documented AF

AF no SA: Patients with AF without surgical ablation

AF and SA: Patients with AF with surgical ablation

Figures

Figure 1: Survival from all cause of death

Legend:
No AF: Patients without preoperative documented AF
AF no SA: Patients with AF without surgical ablation
AF and SA: Patients with AF with surgical ablation

Figure 2: Postoperative pacemaker implantation

Legend:

No AF: Patients without preoperative documented AF
AF no SA: Patients with AF without surgical ablation
AF and SA: Patients with AF with surgical ablation

Figure 3: Composite endpoint for all cause of death, major bleeding and stroke

Legend:

No AF: Patients without preoperative documented AF

AF no SA: Patients with AF without surgical ablation

AF and SA: Patients with AF with surgical ablation

Figure 1

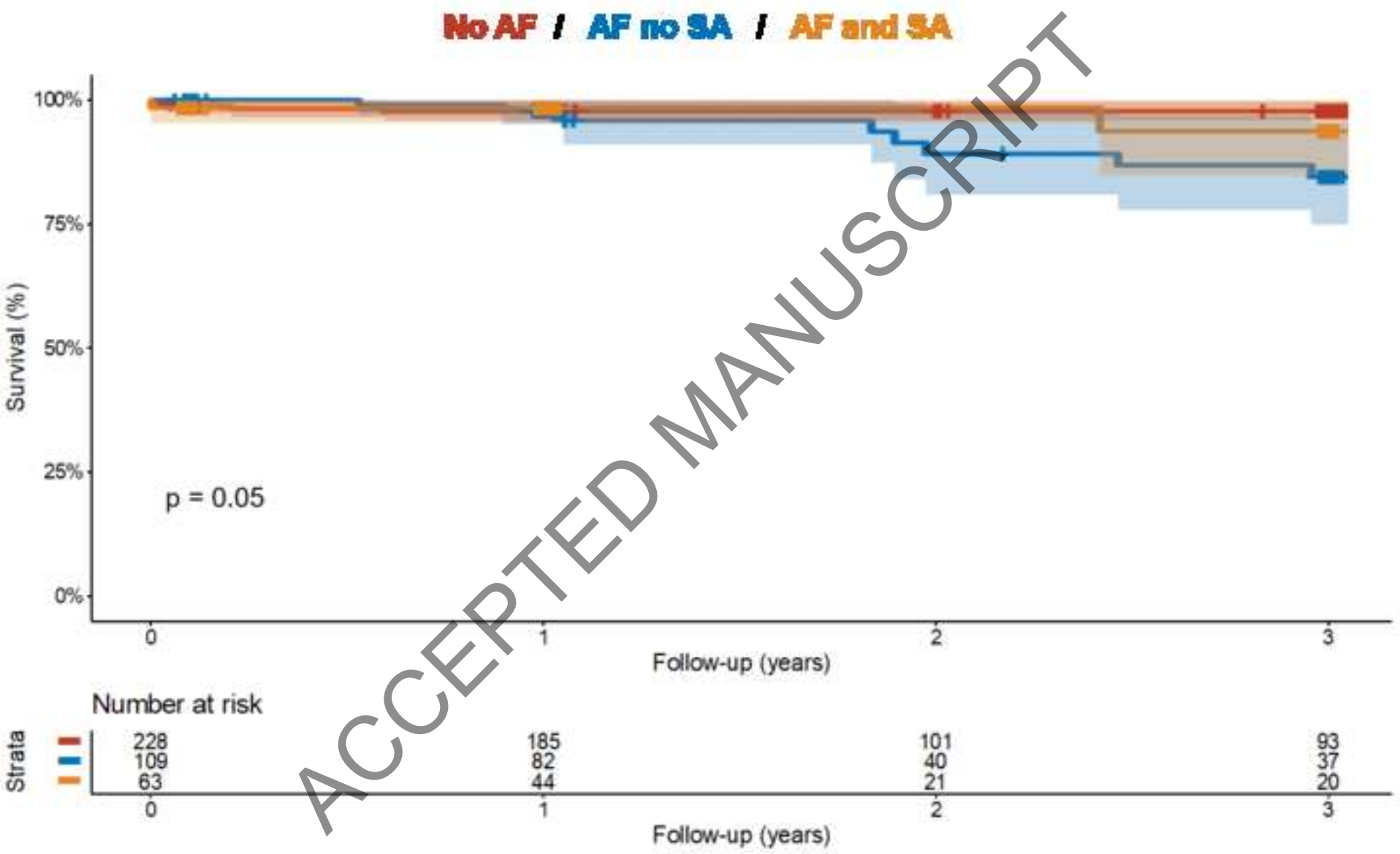


Figure 2

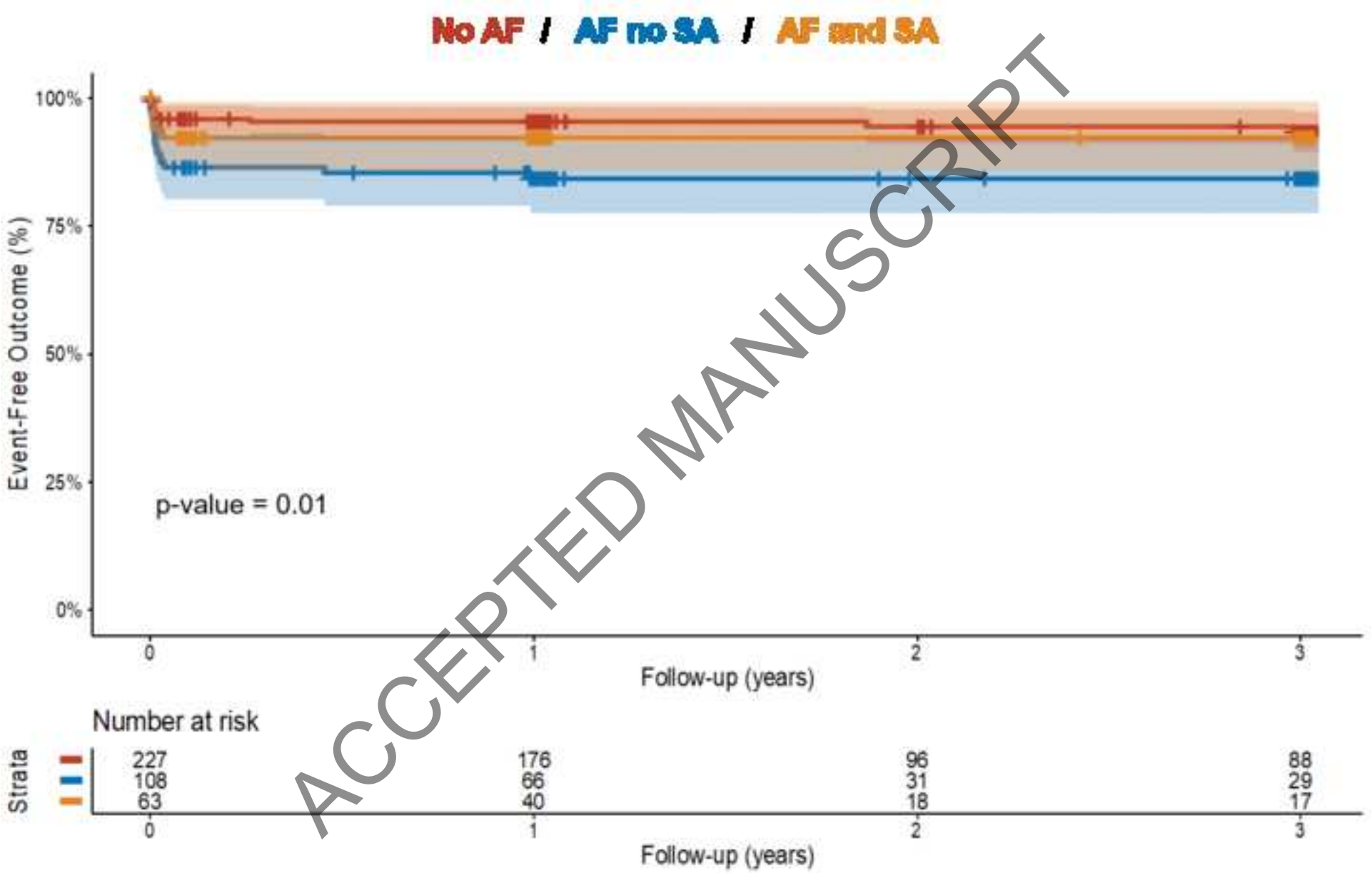
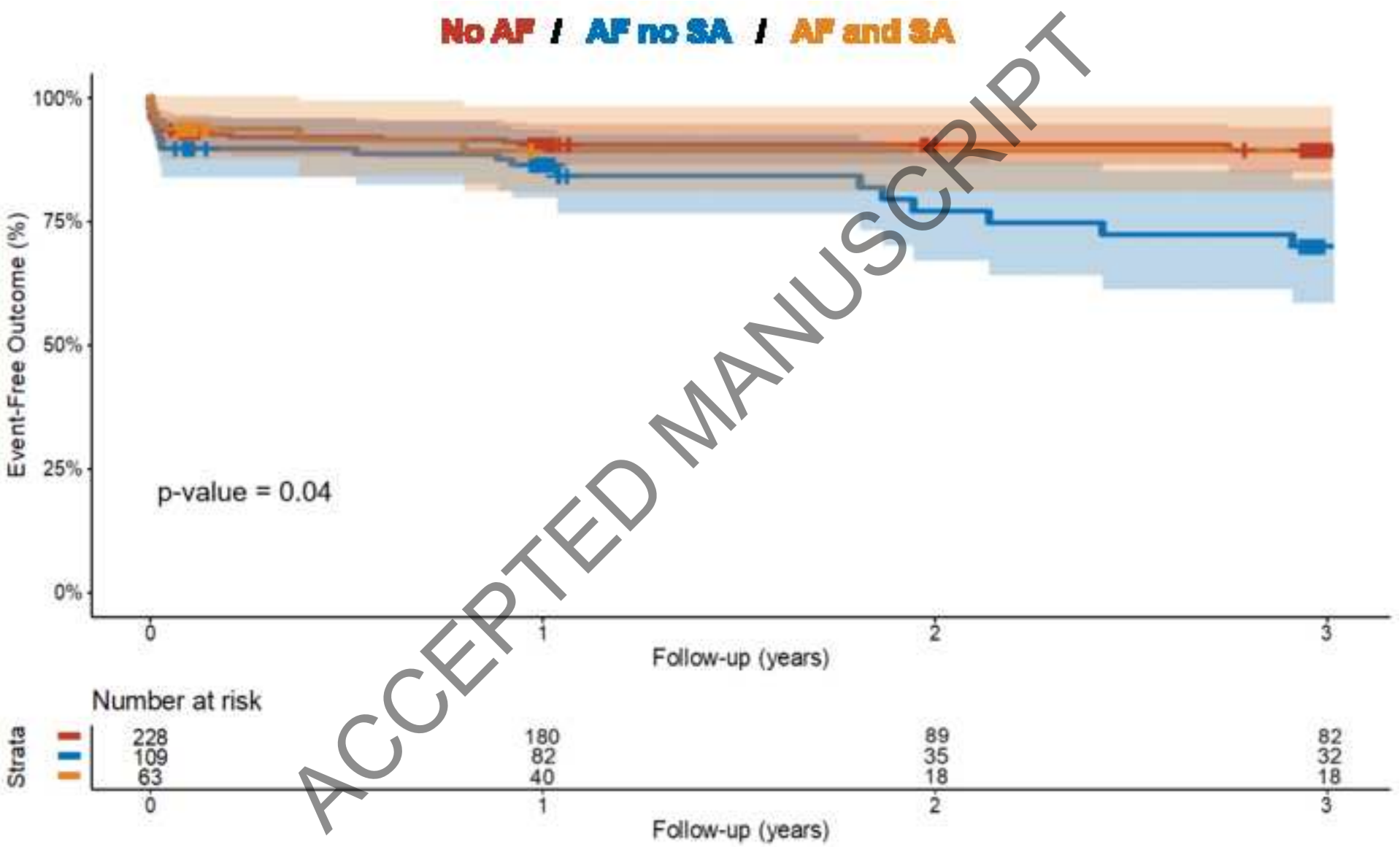


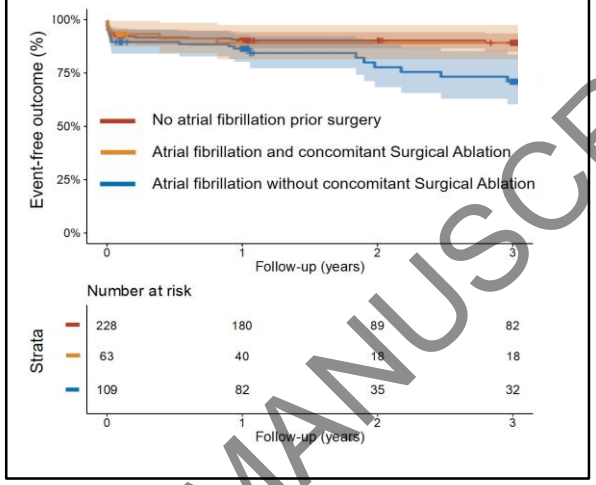
Figure 3



Surgical ablation for atrial fibrillation in mitral valve surgery

Summary

In a retrospective study of 400 patients who underwent mitral valve surgery, we compared patients with and without atrial fibrillation by evaluating the impact of surgical ablation. The results showed that concomitant surgical ablation for atrial fibrillation yields comparable mid-term outcomes to those of patients without preoperative atrial fibrillation.



Legend: freedom from composite adverse events (death, stroke, major bleeding)