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# CONCOMITANT SURGICAL ABLATION OF THE LEFT ATRIUM (LA) USING ELECTROCAUTERY (DIATHERMY) IN PATIENTS UNDERGOING MITRAL VALVE (MV) SURGERY WITH ATRIAL FIBRILLATION (AF); WAS IT EFFECTIVE IN RESTORING SINUS RHYTHM?

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## Abstract

**Background:** Concurrent surgical ablation of the left atrium during a mitral valve surgery has been accepted as a reliable treatment approach for attempting to restore the patient's own sinus rhythm. However, there is no clear favorite ablation procedure among those described in the literature.

**Objective:** The purpose of this study is to assess the effectiveness of surgical ablation with low-voltage electrocautery in reverting AF to sinus rhythm, as well as its short- and mid-term clinical benefits in patients undergoing MV surgery.

**Patients and methods:** We studied 162 cases of chronic MV disease with permanent AF that were operated on at Cairo University, Fayoum University and Beniseuf University Hospitals between March 2016 and February 2021. All cases were diagnosed with AF at least six months before the operation. Patients then were subdivided into two groups; group A or the ablation group that included 80 patients and group B or non-ablation group which comprised 82 patients. Data on postoperative mortality and morbidity, including cardiac rhythm, heart failure, thromboembolic events, and echocardiographic studies, were recorded and analyzed.

**Results:** At 1.15 + 0.58 years of follow-up, *group A* had significantly lower rates of atrial arrhythmias, late mortality from cardiac causes, thromboembolic events, and hospitalization for heart failure than *group B* (P value 0.05). There were no significant differences in terms of early mortality or the necessity for a pacemaker.

**Conclusion:** Surgical ablation for AF using low-voltage electrocautery during an operation for mitral valve disease is effective in decreasing postoperative atrial arrhythmias and their worse outcomes.

**Keywords:** Mitral valve disease, Atrial fibrillation, Electrocautery, and surgical ablation.

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## INTRODUCTION

Atrial fibrillation (AF) and mitral valve disease (MV) are frequently linked in terms of causation and effect <sup>(1)</sup>. More than 30% of patients with MV disease will present with concomitant permanent AF <sup>(2, 3)</sup>.

AF rhythm is a known risk factor for early postoperative cognitive decline <sup>(4,5)</sup>, and it has been demonstrated to increase the postoperative risk of thromboembolic events in cardiac patients even when anticoagulants are used <sup>(6)</sup>. Moreover, the resultant decreased cardiac output in AF patients markedly increases the postoperative risk of heart failure, rehospitalization, and even death <sup>(7)</sup>.

In order to restore the patient's sinus rhythm during the repair or replacement of a diseased mitral valve, numerous surgical procedures have been proposed. However, there is no standard favorable technique <sup>(8,9)</sup>.

We propose a new simple strategy for inducing fibrosis along the widely involved culprit electric pathways in atrial fibrillation that are commonly organized around orifices of the pulmonary veins on entering the LA <sup>(10)</sup>, utilizing low voltage electrocautery energy in our investigation.

## PATIENTS AND METHODS

Randomly, 162 patients with MV illness with concurrent persistent AF were divided into two groups: group A, which contained 80 patients and underwent our proposed surgical ablation; group B, which contained 82 patients and served as a control group for comparison purposes.

**Inclusion criteria:** Patients above the age of 16 with persistent or long-standing AF and are indicated for mitral valve repair or replacement.

**Exclusion criteria:** Patients below the age of 16, paroxysmal AF, previous trial of catheter-based ablations, redo-cardiac surgery, coexistent ischemic coronary disorder, usage of other ablation procedures

such as Cox-maze and cut and sew surgical techniques, and patients with infective endocarditis.

**Definitions:** Long-standing persistent AF was defined as episodes lasting more than 6 months to 365 consecutive days without sinus rhythm, while persistent AF was defined as events lasting more than 7 consecutive days with sinus rhythm <sup>(11,12)</sup>.

The study included 162 consecutive participants who met the above criteria. All patients received the same anesthesia and surgical preparation protocols. All patients had routine preoperative investigations such as an electrocardiogram, a chest X-ray, hemoglobin, urea, electrolytes, serum creatinine, echocardiography, and postoperative close follow up studies at 3, 6, and 12 months after surgery to assess cardiac rhythm.

Preoperative, operative, and postoperative data were collected and compared in both groups, including early and late deaths, freedom from AF, cardiac, and systemic thromboembolic complications, and readmissions for heart failure.

### **Ethical approval:**

An approval of the study was obtained from Fayoum University academic and ethical committee. Every patient's parent signed an informed written consent for acceptance of the operation. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans <sup>(13)</sup>.

### **Surgical technique:**

#### **Mitral valve surgery;**

All patients were operated using the conventional median sternotomy incision and Aorto-bicaval cannulation for cardiopulmonary bypass. Cold blood-based crystalloid cardioplegic solution with local and systemic cooling (28–32 °C) was used to provide myocardial protection.

A left atriotomy incision was utilized to access the mitral valve in 146 (90.2%) of

the patients, while a trans-septal technique was employed in 14 patients with a small left atrial cavity.

In each instance, the mitral valve was repaired or replaced with a synthetic or natural prosthesis, and regardless of the mitral procedure done, the left atrial appendage was closed using a 3-0 polypropylene purse-string suture in all patients in both groups.

### **Ablation Technique;**

Guided by recent data regarding electro-anatomical mapping for AF, we set the spray-mode diathermy pencil at low voltage (30 – 50W) to induce cautery lesions on the endocardial surface along the common mapped electric passages of AF (14-16).

Cautery lesions were carried out encircling orifices of the right pulmonary veins, orifices of left pulmonary veins then a line on the LA posterior wall is made connecting the right and left circles. On ablating along the posterior mitral annulus we typically avoided area adjacent to P1 scallop not to injure the left circumflex coronary artery.

When trans-septal approach was used, we add ablated the Cavo-tricuspid isthmus, posterior inter-caval line and around the coronary sinus orifice.

The low-mode cautery pencil was connected to a diathermy machine (BOWA electrosurgical unit ARC 350) and passed slowly at a rate of 1-3 seconds/cm till endocardial tissue blanching. Field should be bloodless to avoid tissue charring and formation of carbonization products that may cause systemic embolic events if not well washed away before LA closure.

### **Postoperative plan;**

We implemented a strict rhythm monitoring and follow-up plan. For all patients, Amiodarone 200mg (a class III anti-arrhythmic drug) was prescribed daily for three months after discharge. When possible, patients were advised to have an

ECG performed at the time of palpitation; otherwise, Holter monitoring was used to detect any temporary atrial arrhythmias.

Amiodarone was stopped after three months if the patient maintained sinus rhythm with no AF attacks. While in patients with paroxysmal AF, Amiodarone was maintained for another 3 months. Persistence of AF rhythm beyond 6 months of continued Amiodarone therapy was considered an indication for catheter ablation if possible.

Anticoagulant Dicoumarol therapy was used as a life-long therapy in patients who underwent MV replacement using a metallic prosthesis and used only for 6 months in patients we used a tissue valve to replace their diseased MV if they restored their sinus rhythm.

For at least a year after the operation, a quarterly ECG study (with Holter monitoring if necessary) was used to assess the patient's rhythm.

### **Statistical analysis:**

Continuous data were expressed as mean and standard deviation or median with the interquartile range and categorical data as percentages. All reported P values are two-sided, and P values of  $\leq 0.05$  were considered statistically significant. The Kaplan-Meier method was used to assess survival, freedom from atrial arrhythmias, thromboembolic events and hospitalization for heart failure. All statistical analyses were performed with SPSS version 22.0 (SPSS, Inc., Chicago, IL, USA). All statistical analyses were done with the help of a departmental statistician.

## **RESULTS**

### **Demographic and operative variables; Table 1**

#### **Patients;**

162 (55 female, 33.95%) adult patients with coexistent mitral valve disease and AF were included in this study and randomly subdivided into 2 groups.

There was no statistically significant difference regarding sex among the 2 groups (39.02% vs. 28.75%) with P value of 0.181. The mean postoperative follow up duration was 1.15±0.58 years for all patients.

### Operative data;

Cardiopulmonary bypass time was 15 minutes longer in the ablation group

**Table (1):** Demographic and operative variables

	Group a	Group b	P value
Female sex	23 (28.75)	32 (39.02)	0.181
CPB time	120.4±60.8	110±65.9	0.298
Temporary pace maker	16 (20%)	12 (14.63)	0.36

(120.4±60.8) compared to the control group (110±65.9) yet difference was not statistically significant with P value of 0.298.

After aortic declamping, 16 patients (20%) of the ablation group were in junctional temporary rhythm that mandated usage of the temporary pace-maker stimulation.

### Postoperative variables; Table 2

#### Early morbidity and mortality;

There were no in-hospital deaths, no major intraoperative bleeding, and none of our cases were complicated by systemic embolization shortly after the operation.

#### Heart rhythm at follow up;

52 patients (65%) who underwent surgical ablation in our study were free from AF throughout the follow up duration compared to 20 (24.39%) in the control group with P value <0.0001.

Permanent pace-maker insertion was needed in 5 patients among the whole population, 2 of them belonged to group a (P value 0.649).

#### Survival (late mortality);

With a P value < 0.001, late deaths (30 days after surgery) from cardiac causes were significantly higher in the non-

**Table (2):** Postoperative variables.

	Group a	Group b	P value
Sinus rhythm	52 (65%)	20 (24.39%)	<0.0001
Permanent pace maker	2 (2.5%)	3 (3.66%)	0.649
Late deaths	2 (2.5%)	5 (6.1%)	<0.001
Thromboembolic events	15 (18.75%)	30 (36.58%)	<0.0116
Heart failure	4 (5%)	16 (19.5%)	0.0051

ablation group (5 deaths; 6.1%) than in the ablation group (2 deaths; 2.5%).

#### Stroke and re-hospitalization for uncontrolled AF;

Throughout the follow-up duration, thromboembolic events were markedly less frequent in the ablation group (15 (18.75%) vs. 30 (36.58%)) with a P value of 0.0116, and 4 patients from group A (5%) were readmitted for heart failure due to rapid AF compared to 16 (19.51%) in the control group with a P value of 0.0051.

On adjustment with inverse probability weighting, ablation was associated with decreased risk of all-cause deaths (HR 0.675, 95 C.I 0.117, 3.897, P value 0.665), Systemic embolization (HR 0.561, 95% C.I 0.317, P value 0.051) and Hospitalization for HF (HR 0.505, 95% C.I 0.137, 1.888, P value 0.3255).

## DISCUSSION

162 candidates for mitral valve surgery with coexistent persistent and/or longstanding AF were enrolled in our study and randomly categorized into two groups; 80 of them underwent surgical ablation using low voltage diathermy cauterization.

62 percent of patients who underwent surgical ablation according to our methodology were free of AF at 6 and 12 months postoperatively, compared to only 20 percent of no-ablation patients.

This results is comparable to those published by several observational studies and to data extracted by meta-analytical studies (17-20). However, **Gillinov et al.** (21) and **Lee et al.** (22) reported more than 70% freedom from AF in patients who underwent surgical ablation with mitral surgery.

The lower ablation success rates in our trial may be explained by the inclusion of older patients and individuals with long-standing drug-resistant AF (23-25).

**Scherman and Jacques**(26) reported the same success rates using low voltage diathermy compared to other surgical ablation methods in 2009, and there was no difference in the results of surgical ablation using different energy sources, including monopolar diathermy, in a comprehensive survey conveyed by **Brick et al.** (27).

We found that **the cardiopulmonary bypass** time was 15 minutes longer in the ablation group. This result is consistent with data published by **Yavuz and Engin** (28) and **Ma et al.** (29) in 2022. However, this difference was not statistically different regarding our study.

Surprisingly, **permanent pacemakers** were used in three patients in the non-ablation group compared to only two in the other group, which contradicts the results found in most published trials that found a

higher incidence of heart block following surgical ablations (30, 32).

AF rhythm that is found in more than 30% of MV disease demanding surgical intervention is a well-known risk factor for postoperative mortality and morbidity (33, 34). This fact explained statistically lower incidence of **late deaths** among the ablation group (2 vs. 5 with P value < 0.001) that matches well with results approved by many studies (27, 30, 32-35).

In 2013, **Cox et al.** (35) reported at least 5 time increase in incidence of cerebrovascular strokes in patients with postoperative AF. However, **Kim et al. in 2019** (19) disclosed insignificant difference in thromboembolic events nor re-hospitalization on comparing ablation and non-ablation patients.

In our trial, both **thromboembolic events and re-hospitalization for heart failure** were significantly lower in patients who underwent surgical ablation with p values <0.0110 and 0.0051 respectively that agreed with data presented by **Kim in 2021** (20).

Despite the theoretical hazards of using electro cautery as a source of energy for endocardial ablation in AF patient undergoing open heart surgery including tissue charring and embolic events as suggested by **Cox et al.** (35) these hazards can be easily avoided by using low voltage energy and proper removal of the carbonization products from interior of the LA prior its closure and aortic declamping.

## CONCLUSION

We propose that usage of low voltage diathermy is a safe method of surgical ablation in patients undergoing mitral valve surgery with satisfactory outcome regarding freedom from AF at 6 and 12 months follow up.

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