

The effect of atrium diameter on the successful treatment of atrial fibrillation through the radiofrequency ablation technique

Atriyal fibrilasyonun radyofrekans ablasyon tekniği ile tedavisinde atriyum çapının tedavi başarısına etkisi

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Background: In this study, we aimed to determine the effect of atrium diameter on the successful treatment of atrial fibrillation through the radiofrequency ablation technique.

Methods: Between January 2003 and December 2010, 124 patients with chronic atrial fibrillation who were scheduled for mitral valve surgery due to mitral valve disease in our heart and vascular surgery clinic were retrospectively analyzed. The patients were examined in two main groups which were divided into four subgroups. While dividing them, the type of ablation technique and the left atrium diameter were taken into consideration. The preoperative, intraoperative, and postoperative data of the patients were assessed.

Results: In our study, it was determined that very successful results were achieved for both patient groups in the evaluations based on the left atrium diameter of those subjects who underwent both unipolar ablation and bipolar ablation. In addition, return to sinus rhythm in patients with a left atrium diameter of <60 mm who underwent unipolar ablation occurred at about 80% rate, which was similar to the patients with a left atrium diameter of >60 mm. Comparable results were also obtained with the patients who underwent bipolar ablation. In the patient follow-up, it was observed that the postoperative rhythm of each patient group were stable.

Conclusion: Regardless of the diameter of the left atrium, the results of radiofrequency ablation surgeries with the radical technological developments today are satisfactory.

Key words: Atrial fibrillation; atrium diameter; radiofrequency ablation.

Amaç: Bu çalışmada atrial fibrilasyonun (AF) radyofrekans ablasyon tekniği ile tedavisinde atriyum çapının tedavi başarısına etkisi değerlendirildi.

Çalışma planı: Ocak 2003 - Aralık 2010 tarihleri arasında kalp damar cerrahisi kliniğimizde arasında mitral kapak hastalığına bağlı mitral kapak cerrahisi yapılması planlanan kronik atrial fibrilasyonlu 124 hasta retrospektif değerlendirildi. Hastalar iki ana dört alt grupta incelendi. Gruplama yapılırken uygulanan ablasyon tekniğinin tipi ve sol atriyum çapı dikkate alındı. Hastaların ameliyat öncesi, ameliyat sırası ve ameliyat sonrası verileri değerlendirildi.

Bulgular: Çalışmamızda unipolar ablasyon ve bipolar ablasyon uygulanan hastaların sol atriyum çaplarına göre yapılan değerlendirmelerinde her iki hasta grubu açısından da çok başarılı sonuçlar elde edildiği saptandı. Ayrıca sol atriyum çapı <60 mm olan ve unipolar ablasyon yapılan hastalarda sinüs ritmine dönüş %80 civarında iken, bu oran sol atriyum çapı >60 mm olan hastalarda da benzer bulundu. Bipolar ablasyon yapılan hastalarda da benzer sonuçlar elde edildi. Hastaların yapılan takiplerinde de bütün hasta gruplarında ameliyat sonrası sağlanan ritimlerin stabil olduğu gözlemlendi.

Sonuç: Sol atriyum çapından bağımsız olarak, günümüzdeki radikal teknolojik gelişmeler eşliğinde yapılan radyofrekans ablasyon cerrahilerinin sonuçları oldukça tatmin edicidir.

Anahtar sözcükler: Atrial fibrilasyon; atriyum çapı; radyofrekans ablasyon.



Available online at
www.tgkdc.dergisi.org
doi: 10.5606/tgkdc.dergisi.2012.097
QR (Quick Response) Code

Received: November 16, 2011 Accepted: December 20, 2011

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Atrial fibrillation (AF) is a common rhythm problem worldwide and was first defined by Levis in 1909^[1] It is found in 0.4-1% of the general population, but the rate increases with age to 10%, especially in those over 65 years of age with ranges of 40-60% in mitral valve patients and 5-10% in coronary and aorta valve patients.^[2]

During the treatment of AF in patients with cardiac pathologies, radiofrequency ablation (RFA) treatments have become the norm.^[3] The Cox maze III procedure was developed by Cox et al.^[4] and depends on the principle of left atrial isolation. It has been the gold standard for years with very successful results. However, various other methods are now in vogue which utilize different energy sources and are easy to use. Their success depends on the experience of the surgeon along with whether the cardiopulmonary bypass and operation were prolonged and whether there were any postoperative risks, such as drainage. Studies have been done using cryoablation, microwave, electrocauterization, ultrasonography, laser and RFA, but of these energy sources, the most common are cryoablation and RF because of their easy application and the wide range of date which they provide.^[4]

In this study, we examined the efficacy of unipolar-bipolar RFA treatments regarding the left atrium (LA) diameter in patients who underwent valve surgery in our clinic.

PATIENTS AND METHODS

In the heart and vascular surgery clinic of our hospital, 124 patients with chronic atrial fibrillation who underwent mitral valve surgery due to mitral valve disease between January 2003 and December 2010 were studied retrospectively.

The New York Heart Association (NYHA) scores gathered from the preoperative assessments of the patients are summarized in Table 1.

Group 1 (group 1a: LA diameter ≤60 mm; group 1b: LA diameter ≥60 mm) involved 56 patients who underwent unipolar ablation and valve surgery, Group 2

(group 2a: LA diameter ≤60mm; group 2b: LA diameter ≥60 mm), on the other hand, included 68 patients who underwent bipolar ablation and valve surgery. The median follow-up of 2.3 (range 1.2-3.4 years) years was similar in the two groups (Figure 1).

Echocardiographic evaluations related to the atrium diameter of the valve disease of the patients were made by the same cardiology staff, and the level of mitral valve stenosis or insufficiency, additional pathologies in the other valves, atrium and ventricular diameters, ejection fraction, and pulmonary artery pressure were all measured. In the intraoperative assessment, parameters such as cardiopulmonary bypass (CPB) time, duration of stay in the operating room, postoperative rhythm character, and duration of stay in the intensive care unit (ICU) were determined.

The unipolar ablation technique was used in the AF treatment for the patients in group 1. Following the median sternotomy, bicaval cannulation and CPB were performed. A left atriotomy was then carried out after inserting a cross-clamp. Afterwards, the process of radiofrequency was performed using the Medtronic Cardioblade™ ablation system (Medtronic, Inc., Minneapolis, Minnesota, USA) composed of a power generator and an ablation clamp. In this study, 25 W power and 5 ml/min irrigation speed were used in the applications of unipolar RFA with irrigation. The contact surface was cooled by providing irrigation through the holes on the tip of the catheter, and lesions were formed by reaching the effective ablation power in the deep tissues. The finding of a whitish discoloration on the surface of the endocardium indicated that the ablation was completed. In view of this data, the right pulmonary veins were isolated by combining the left atriotomy

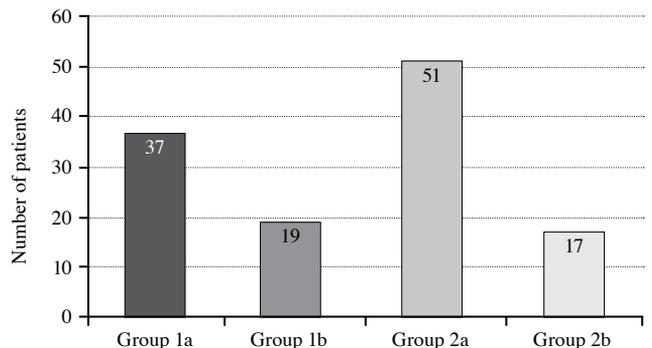


Figure 1. The graphical representation of the distribution of patients according to groups. Group 1a: Patients whose left atrium diameter was ≤60 mm and who underwent unipolar ablation; Grup 1b: Patients whose LA diameter was ≥60 mm and who underwent unipolar ablation; Grup 2a: Patients whose LA diameter was ≤60 mm and who underwent bipolar ablation; Grup 2b: Patients whose LA diameter was ≥60 mm and who underwent bipolar ablation.

Table 1. The assessment of the patients through NYHA scoring

NYHA score	Group 1		Group 2		p
	n	%	n	%	
II	12	21	16	23	NS
III	23	41	39	57	NS
IV	21	38	13	20	NS

NYHA: New York Heart Association; NS: Nonsignificant.

incision from both ends forming a half-moon-shaped lesion. Later, the left pulmonary veins were isolated by forming a lesion with an elliptical shape. These two isolated islets were connected with a straight line. Then the procedure was completed by forming a lesion with a straight line through the left vein pulmonary islet to the LA appendix and mitral valve posterior annulus. Next, internal ligation was applied on the left atrial appendix.

Since the suture material could have been exposed to thermal damage before the ablation process, the procedure related to the mitral valve was performed after that process was completed. When the application relative to the LA was completed, the procedure for the right atrium was begun. Following the right atriotomy, a linear lesion was formed towards the vena cava inferior and vena cava superior. Afterwards, another lesion was constructed through the right atrium appendix to the septal leaflet. A lesion was then erected from the posterior leaflet to the right atrium fornix in conjunction with the incision. From the sub-end of the right atriotomy to the coronary sinus ostium through the fossa ovalis, another lesion was also established. The ablation procedure was finally completed by forming lesions through the posterior leaflet and vena cava inferior, which was followed by the appendix ligation. The surgical procedure related to valve pathology then commenced.

Following the valve change or repair, the process was completed, and the patient was taken off of CPB.

After cross-clamping, all patients were given a 600-800 mg/day dose of amiodarone infusion, and a temporary epicardial pacemaker wire was inserted. Once the decannulation process was completed, the patients with AF were given internal electrical cardioversion.

The bipolar ablation technique utilizing the same ablation system as group 1 was used for the patients in group 2 with bipolar RFA. With this system, the tip of the ablation clamp is atraumatic, and the target tissue is stabilized between the two ends. The RF energy passes through this tissue. By providing irrigation between the clamp and tissue surface simultaneously, the tissue is cooled which maintains the tissue temperature between 45 and 55 °C. Furthermore, the clamp emits a signal indicating the formation of a transmural lesion by measuring the impedance between the two electrodes. This process of generator ablation ends spontaneously through this mechanism. Thus, a safe and controlled transmural ablation line is formed. This type of system can also be used with off-pump and minimally invasive techniques.

With this data in hand, standard CPB was conducted on our patients after a median sternotomy. Following the left atriotomy, a thrombectomy was first performed on the subjects with thrombus. The left pulmonary veins were explored and set free, and both pulmonary veins were isolated as islets by applying epicardial bipolar ablation. Next, a lesion was formed by applying epicardial ablation to the LA appendix. By connecting with the left atriotomy incision, a lesion was constructed by inserting one end of the bipolar catheter on the epicardial surface and the other end around both right pulmonary veins. Epicardial bipolar ablation was also performed in the right atrium. After completing the process of ablation, left atrial internal ligation was administered. Later, the procedure related to the mitral valve was completed. After cross-clamping, all patients were given a 400-600 mg/day dose of amiodarone infusion, and a temporary epicardial pacemaker wire was inserted into each patient. Following the decannulation process, internal electrical cardioversion was administered to those patients with AF.

Those patients having postoperative amiodaron infusion were assessed again in the ICU in terms of their rhythm. The infusion was discontinued in two of the patients who developed bradycardia, and a temporary pacemaker wire was then inserted. In those patients whose PR interval was longer than normal as revealed by electrocardiography, the dose of amiodaron infusion was reduced, and more frequent follow-ups were made. Those patients with a postoperative sinus rhythm which returned to an AF rhythm in the ICU were administered electric cardioversion after sedation. The patients with no hemodynamic problems were followed up with service monitoring, and all the patients were discharged from the hospital after planning their anticoagulant and antiarrhythmic treatments. Antiarrhythmic amiodaron treatments were suggested for at least three months.

Statistical analysis

Comparisons between the groups were performed using Student's t-test or the Wilcoxon rank-sum test for continuous variables along with the chi-square or Fischer's exact test for categorical variables. Kaplan-Meier analysis was performed to determine the probability of survival, and survival curves were compared using the log-rank test. All values were considered to be statistically significant with a *p* value of less than 0.01.

RESULTS

In our study, both patient groups were examined retrospectively. Of the patients in group 1, 20 were male and 36 were female with ages ranging from 28 to 67.

Table 2. Demographic information

	Group 1		Group 2		p
	n	%	n	%	
Gender					
Male	20		29		NS
Female	36		39		NS
Age (years)	46		52		NS
Hypertension	12	22	16	24	NS
Diabetes mellitus	9	16	3	5	NS
History of embolic events	1	2	2	3	NS

NS: Nonsignificant.

The mean age was 46. There were 29 male and 39 female patients in group 2, and their mean age was 52 (range, 19-74 years). Twelve patients in group 1 and 16 in group 2 had hypertension, and nine patients in group 1 and three in group 2 had diabetes mellitus (Table 2).

In the preoperative ecocardiographical evaluation, it was determined that the mean diameter of the patients in group 1 was 57 mm while it was 54 mm in group 2. Nineteen patients (34%) in group 1b were discovered to have an LA diameter of over 60 mm while there were 17 (25%) in group 2. We also found that 14 patients (74%) in group 1b had a postoperative normal sinus rhythm (NSR), while there were 13 (68%) in group 2b.

The number of patients in group 1 with an LA diameter of under 60 mm was 37 (66%), and five (8%) of them had no postoperative sinus rhythm. The number of patients in group 2 with an LA diameter of under 60 mm was higher at 51 (75%), and seven (10%) of those had no postoperative sinus rhythm. The remaining 44 patients (65%) maintained NSR (Figure 2-4).

In the rhythm assessments of the patients made during the first-month postoperative follow-up, it was determined that the sinus rhythm continued in 30 of 32 patients in group 1a (37 in total) who returned to NSR,

but only two of them developed AF again. In contrast, among the five patients with postoperative AF in this group, only one of them had NSR. Out of the 14 patients in group 1b (19 in total), only one of them had AF. Nevertheless, it was determined that one patient who did not develop NSR had sinus rhythm. According to this data, 31 patients (83%) in group 1a had NSR at the end of the first month, whereas there were 14 (79%) in group 1b.

In the first-month follow-ups of the patients in Group 2a (51 patients in total), it was observed that among the 44 patients who initially returned to sinus rhythm, only one of them developed AF. Additionally, two of the seven patients with AF who were followed up in the postoperative ICU returned to sinus rhythm. Out of the 14 patients in group 2b who returned to sinus rhythm, only one of them developed AF, and two of the five patients with AF developed sinus rhythm (Figure 5).

At the six-month follow-ups, it was reported that only one patient in group 2a returned to AF. The rhythm in all other patients continued, and the rhythms of the patients who returned to sinus were not temporary (Figure 6).

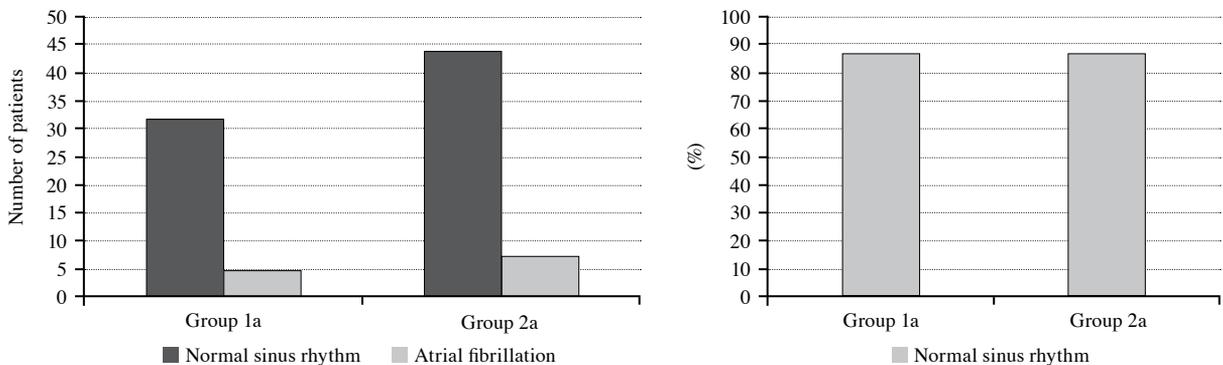


Figure 2. The comparison of the postoperative rhythm of the patients whose left atrial diameter is ≤ 60 mm according to ablation technique

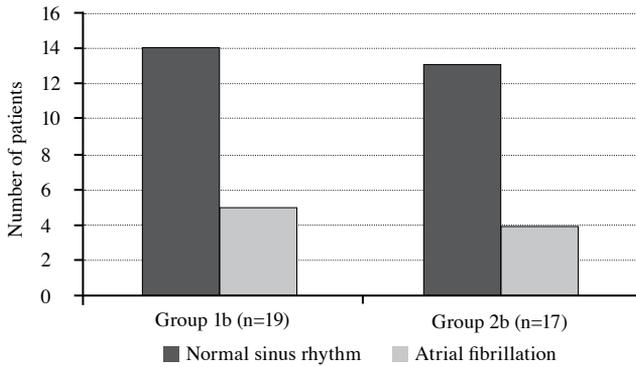


Figure 3. The comparison of the postoperative rhythms of the patients whose left atrial diameter is ≥ 60 mm according to ablation technique.

It was also discovered that six patients in group 1 (during 40 months follow-up) had died and that the 12 patients in group 2 had either died suddenly, or their deaths were distinctly attributable to a cardiovascular cause. This value was not statistically significant ($p=0.14$).

DISCUSSION

Atrial fibrillation (AF) is an arrhythmia which causes serious clinical problems and becomes more common with age. The chronic symptoms caused by AF have a negative impact on the general well-being of patients and their quality of life. Other complications such as systemic embolism, hemodynamic dysfunction, congestive heart failure, and cardiomyopathy are also found in these patients.^[5]

Mitral valve diseases are the leading disorders among the many cardiac and non-cardiac factors in AF development. Patients with valve disease and rhythm disorder have a wide spectrum of symptoms,^[6] including palpitation, dyspnea, and those caused by heart failure

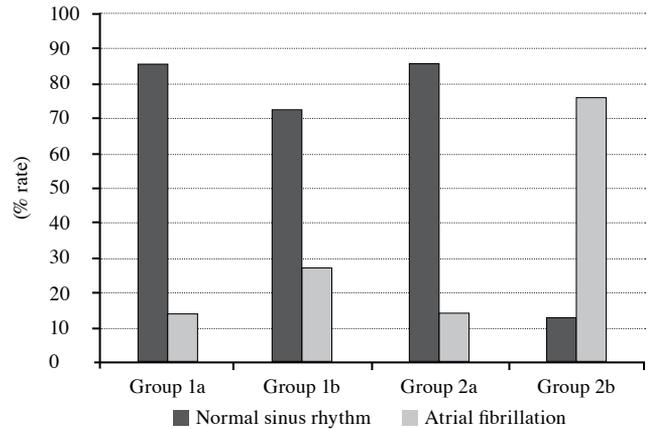


Figure 4. The graphical representation of success rates of the treatments applied on patients grouped according to left atrial diameter.

or thromboembolism, and they are admitted to hospitals at various stages according to the severity of the symptoms. Therefore, their LA diameters are of different sizes when they have surgery.^[7]

A vast majority of the patients operated because of mitral valve disease have atrial fibrillation rhythm. The rhythm after the mitral valve operation in patients with intermittent or a short-term AF (less than a year) generally returns to sinus, but this rate is quite low for those with chronic atrial fibrillation.^[8] When mitral valve disease and chronic AF occur simultaneously, it has been observed that AF perseveres in more than 80% of the subjects if the surgical approach has focused only on the valve.^[9] In a study by Melo, on the other hand, it was reported that the number of patients who return to postoperative spontaneous sinus rhythm was 8%.^[10]

Whatever the reason, the duration and chronic tendency of AF are the determining factors for a successful treatment. Although chronic AF is quite

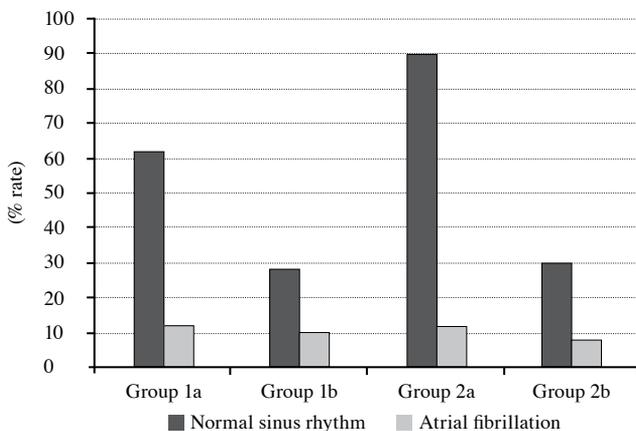
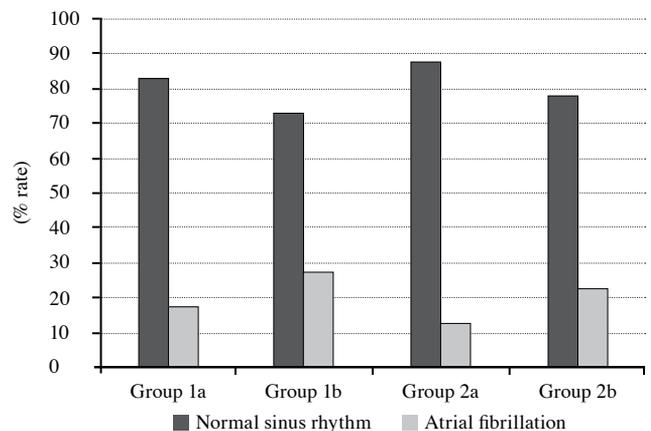


Figure 5. The rhythm analysis in groups at the end of the first month and the percentage of these rhythms.



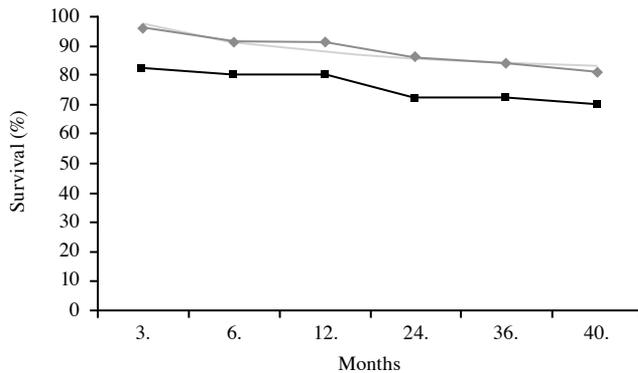


Figure 6. Probability of survival as a function of left atrial diameter ($p=0.14$).

resistant to most medical treatments, it can be resolved easily through appropriate medical procedures.^[11] Therefore, in this study we examined the efficacy of surgical methods for AF. These were then administered to the patients who needed mitral valve surgery based on their LA diameter.

When the early period results of unipolar and bipolar RFA with irrigation were compared, no significant difference was found in the results in our study. We also clearly observed that a larger LA diameter did not affect the success rate of the AF repair procedure. After unipolar RFA treatment was administered to the patients in group 1a who had LA diameters of less than 60 mm, it was found that almost 86% of them returned to sinus rhythm, whereas 73% of the 19 patients in group 1b with LA diameters of greater than 60 mm maintained NSR. No significant differences were found in the statistical analysis.

Also, our data showed that the long preoperative periods and chronic AF rhythms in most of the patients of group 1b had quite an impact when the data was analyzed. However, the sinus rhythm obtained in the patients of our series was about 80% which contrasted with previously conducted studies. In the study made by Sie et al,^[12] it was reported that AF still continued in 30% and 40% of the patients in the third month while this rate was reported to be almost 20% in our study.

It is also thought that amiodaron, which was given to our patients just after the operation and used for the first three months postoperatively, played a significant role in our results. Geidel et al.^[13] suggested that postoperative use of amiodaron should be for the first three months, and, thanks to this treatment, atrial premature contractions (APC) and early and small macro “re-entries” can be prevented. It has also

been reported in previous studies that the causes of postoperative atrial fibrillation during the first period were a shortened refractory period and small macro “re-entries”.^[14] We think that amiodaron, which was also used in our study, prevented this from occurring and limited the development of AF.

Among the 51 patients examined in group 2a in our study who underwent bipolar ablation and had LA diameters of less than 60 mm, almost 86% of them returned to sinus rhythm, and the rate was 82% among the 17 patients examined in group 2b who underwent bipolar ablation and had LA diameters of greater than 60 mm. Gillinov et al.^[15] reported the results for the success rates using the bipolar RFA method were similar to those of the unipolar method (70% and 80%, respectively). The 86% success rate in the monopolar method and the 82% success rate in the bipolar method in our study indicate that both methods could be easily and successfully used in patients with larger LA diameters.

In previously published studies, the success rate for patients with larger LA diameters who were administered both the unipolar and bipolar methods was high. Melo et al.^[16] claimed in their study that the determinant was not LA diameter but that LA volume was more crucial, and they reported better and more satisfactory results for patients with an LA volume of less than 200 cm³.

In conclusion, regardless of the LA diameter, the results of the RFA surgeries together with the radical and serious technological advancements of today have proven to be satisfactory.^[17] Furthermore, it is clear that since this type of treatment is generally performed during the repair of another cardiac pathology, it will not lead to any surgical burden on the part of the patient, but it will actually contribute to resolving the rhythm problem.^[17]

Declaration of conflicting interests

The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding

The authors received no financial support for the research and/or authorship of this article.

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