Surgery for atrial fibrillation using radiofrequency catheter ablation: assessment of results at one year

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Abstract

Objective: The results obtained in 43 patients using direct intraoperative radiofrequency catheter ablation, as an alternative to surgical incisions, to perform atrial fibrillation surgery, are presented. Methods: Forty-three patients with ages ranging from 43 to 74 years (x = 59), with chronic atrial fibrillation with an average duration 6 ± 5 years were operated. Eleven patients suffered from clinically relevant tachyarrhythmia and eight had previous thromboembolic events. All but one patient had concomitant mitral valve surgery. Direct intraoperative radiofrequency catheter ablation was used to perform endocardial bilateral isolation of the pulmonary veins from the left atrium. Results: There were no local or general complications, namely bleeding or thromboembolic events. Of the 33 patients with more than 3 months of follow-up, 36% remained in atrial fibrillation (Santa Cruz score 0); 30% had Score 4; 18% had Score 3; 6% had Score 2; 9% had Score 1. Conclusions: We conclude that the use of intraoperative radiofrequency catheter ablation is fast and safe. Presently, this is our method of choice for surgical treatment of atrial fibrillation in mitral patients. © 1999 Elsevier Science B.V. All rights reserved.

Keywords: Atrial fibrillation surgery; Radiofrequency catheter ablation; Bilateral pulmonary vein isolation; Arrhythmia surgery

1. Introduction

Atrial fibrillation (AF) is a well known risk factor for thromboembolism [1], it decreases cardiac output and, in many patients, is badly tolerated, being responsible for severe complaints, in spite of medical treatment [2–4]. Consequently, attempts have been made to treat this condition, particularly in mitral patients.

Several methods for the surgical treatment of AF have been described [5–8], the most common approach, in mitral patients, being the ‘maze’ operation. Excellent results with this and alternative techniques have been reported [9–11]. In mitral patients, our 2-year results with the ‘maze’ I and III as well as with the partial left atrial exclusion gave also good late result, if only eradication of fibrillation was considered. However, the results were poor with regard to restoration of bilateral atria contraction [12,13].

We believed that improvement could be achieved by developing a method that would hasten the surgical proce-
34 and grade II in three. Average duration of AF was 6 ± 5 (mean ± SD) years. Eleven patients suffered from severe, very symptomatic tachyarrhythmia, with hemodynamic repercussions leading to frequent hospitalizations and eight had previous thromboembolic events.

Rheumatic mitral valve pathology was mixed in 19 patients, stenosis in 11 and insufficiency in 10. One patient had mitral prosthesis leak. Associated pathologies were present in eight patients (aortic valve disease in five, tricuspid regurgitation in eight, coronary artery disease in two and atrial septal defect in one).

The average size of the left atrium, measured by transesophageal echocardiography, was 54 ± 8 mm.

2.2. Surgery

Surgery was performed under extracorporeal circulation, using either the standard method (25 patients) or the port-access system (eight patients). After cardiopulmonary bypass was established, patients were cooled to 30°C. Myocardial protection was achieved with cold crystalloid cardioplegia infused ante- and retrogradly. The left atrium was opened with an incision parallel to the interatrial groove in front of the right pulmonary veins and inspection of the atrial cavity and mitral valve was performed. If the valve was to be replaced it was excised, preserving, whenever possible, the posterior leaflet.

The radiofrequency catheter was placed inside the left atrium in such a way that a continuous line around the right pulmonary veins was obtained, extending the incision in front of the pulmonary veins around its superior, posterior and inferior limits. To assure better contact, two silk stitches were placed to fix the catheter against the atrial wall. Before initiating the radiofrequency ablation procedure, cold saline was infused inside and outside the atrium. Ablation was then performed by firing sequentially each one of the four electrodes of the radiofrequency catheter (Cerablate, Sulzer Osypka GmbH, Grenzach, Germany) during 30 s, to achieve a temperature of 60 to 70°C. A generator HAT 200 S Sulzer Osypka GmbH, was used as energy source.

A second circular ablation, around the left pulmonary veins’ os, was done, using the same sequence and cautions. All patients had isolation of the bilateral pulmonary veins performed as shown in Fig. 1.

The number of applications required depended upon the size of the atrial cuff of the pulmonary veins. If clots formed around the electrodes, leading to discontinuity of the ablation line, the procedure was repeated.

After radiofrequency ablation was completed, the left atrial appendage was surgically excluded, tying it from outside. The mitral and additional associated surgical procedures, if required, were then performed in a conventional way. Mitral valve operations were either replacement, repair or leak suture. Associated procedures included tricuspid repair, aortic replacement, coronary revascularization and ASD closure (Table 1).

2.3. Follow-up

Patients were evaluated on discharge from hospital, and at 3 and 6 months thereafter.

Results of atrial fibrillation surgery are described using the Santa Cruz Scores as previously reported [13]. Briefly, Score 0 is defined as persistence of atrial fibrillation and thus a failure. Score 4 is attributed when normal sinus rhythm with bilateral atrial contraction is achieved, and is considered a success. Scores 1, 2 and 3 include intermediate, less successful grades, where atrial fibrillation is absent, but normal sinus rhythm is not attained. In Score 1 the atria do not contract and are hemodynamically silent. In Score 2 only the right atrium is beating and in Score 3, both atria contract but without sustained sinus rhythm.
Rhythm was determined on the basis of 12-lead electrocardiogram and 24 h Holter monitoring.

Hemodynamic response of atrial contraction was assessed by identification of a biphasic wave at the level of the tricuspid and mitral valves using color coded Doppler echocardiography.

3. Results

The mean number of radiofrequency catheter applications per patient was 8 ± 2. Of these, usually two catheter applications were enough to achieve full encircling of the right pulmonary veins’ cuff, the remaining being required to isolate the left pulmonary veins. The mean number of radiofrequency electrode ablations was 20, ranging from 16 to 40. The time required for the ablation procedure varied from 15 to 35 min.

As a consequence of the ablation there were no local or general complications, namely atrial wounds. Local clots, that were immediately removed by active aspiration, formed in 20% of the applications.

On average, total myocardial ischemic time was 78 (±24) min, and the duration of extracorporeal circulation 109 (±37) min. The total length of the operation was 3.2 ± 1.1 h. The blood loss was on average 800 ± 600 ml.

No bleeding, attributable to the radiofrequency procedure, occurred.

No severe arrhythmias were observed and no pace-maker implants were necessary. There were no myocardial infarctions and CPK/MB enzymes after surgery were 539/34 IU/ml.

The length of hospitalization was 10 ± 5 days. No patients died early or late.

Follow-up is 100% complete. The length of follow-up is up to 20 months. Thirty-three patients have more than 3 months of follow-up. Of these 20 are in class I, 11 in class II, and two in class III.

Twelve patients remained in AF, and 10 regained normal sinus rhythm. The remaining 11 patients had different supraventricular rhythms.

Echocardiography showed that 18 patients had the right atrium contracting and 16 both atria contracting. The results of the operations using the Santa Cruz scores are described in Table 2. Around one-third of the patients remained in atrial fibrillation, one-third was cured, and one-third was in an intermediate situation. Forty-eight percent of the patients had bilateral atrial contraction.

In four mitral repair patients, because they had both atria contracting 3 months after surgery, we felt that it was safe to discontinue anticoagulants.

4. Discussion

Comparison between published results of atrial fibrillation surgery, from distinct groups, is difficult. Differences in criteria for patient selection and for assessment of the surgical results, can contribute to the discrepancies between our results and those reported by others. However it is possible to compare the results from different techniques within our own series of patients, since we have used consistent selection and evaluation criteria.

Because spontaneous recovery of sinus rhythm, after mitral surgery, is possible, we have selected those patients in whom the likelihood of such recovery would be minimal. In our own series of patients submitted to mitral surgery, those that had chronic atrial fibrillation (more than 1 year of duration), have only 8% chance that the atrial fibrillation disappears, after surgery. So we selected the patients with well established fibrillation, so that any change in the rhythm, after surgery, could be considered, beyond any doubt, the result of the anti-arrhythmic procedure.

The Santa Cruz score [13] considers rhythm and contraction of each atria, for the assessment of the end result of these operations. Because of its multifarious based ranking, it becomes a more accurate way of evaluating results, thus substantiating the comparison between different methods.

In our hands, conventional surgical techniques such as maze I, maze III and pulmonary vein isolation (PVI) [13], in mitral patients with chronic AF, resulted in a low rate of patients with scores 3 and 4. It is worth pointing out that the procedure we then named PVI would have been better described as partial left atrial exclusion (LAE). Because we believe that the hemodynamic function of the left atria is extremely important, we have developed a new surgical technique based upon recent experimental data suggesting that ectopic foci, located at the inflows of the pulmonary veins, can act as initiators of atrial fibrillation [16,18]. The new method consists in the exclusion of a cuff of atrial myocardium that includes the pulmonary veins’ entrance, maintaining the integrity of the left atrium. With this approach, 48% of the patients regained function in both atria. Most likely, the absence of scars in the middle of the left atrium accounts for this improvement in contractility.

Even though our experience is too recent and small it is consistent with the concept that, in many mitral patients, the pulmonary veins’ os are involved in the triggering of atrial fibrillation. Our results with this approach are concordant

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<th>Santa Cruz score</th>
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with those from other groups who have done it percutaneously with RFCA.

Our goal has not been reached because only 50% of our patients are in score 3 or 4. Recent data on the origin of AF revealed the presence of several ectopic points in the left atrium, 70% of which were in the pulmonary veins’ os. The remaining were elsewhere in the right atrium as well as in the left. We believe that achieving full success depends upon knowledge of the precise location of these points, as well as a better definition of the selection criteria of the patients.

Another innovation we introduced was the replacement of surgical incisions by tissue ablation, using radiofrequency catheters [19]. As previously mentioned, this technique has been used by electrophysiologists for percutaneous treatment of atrial arrhythmias and is associated with a variable degree of thromboembolic events. The latter route is, however, safe with regard to wall laceration. Likewise, our initial experimental work in sheep as well as the subsequent endocardial application of RF in humans has never led to either acute or late perforation ([17] and Melo et al., manuscript in preparation). Furthermore, with surgical endocardial ablation late thromboembolic events have never occurred.

Experimental and clinical work has shown that, if the correct RF parameters were used, the lesions were always transmural ([18] and Melo et al., in preparation).

The present results show that the use of intraoperative radiofrequency is safe and fast, thus, providing surgeons with an additional tool to exclude functionally areas of the heart without anatomic interruptions. It can replace surgical incisions and subsequent suture in a number of operations.

It is clear that BPVI with RF is a very fast procedure and the risk for complications is minimal, if carefully used. At the moment, this is the most effective and safe method to induce scars in the atria. Development of catheters specifically designed for this purpose will further hasten and improve the efficacy of this procedure.

5. Conclusions

We conclude that atrial fibrillation surgery can be safely performed with intraoperative RFCA, the final results being as good as with surgical incisions. Because it has the advantage of being faster and safer, this method expands the indications for atrial arrhythmia surgery.

In our experience the procedure we describe as isolation of the pulmonary veins is a good alternative for the treatment of atrial fibrillation.

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References

Appendix A. Conference discussion

Dr Y. Louagie (Mont Yvoir, Belgium): Given an incidence of failure reaching one-third in your group, did you assess the risk factors for recurrence? Particularly, did you study electrophysiologically before the ablation procedure criteria that could predict an arrhythmia recurrence? For example, was atrial fibrillation originating from the right atrium not a factor of early recurrence since your procedure is concentrating on the left atrium exclusively?

Dr Melo: As you know and as I have said, we have operated on chronic atrial fibrillation, so we have no possibility of doing preoperatively electrophysiological studies on atrial fibrillation, because to do those studies the patient has to be in sinus, and those patients are in chronic atrial fibrillation. That is the reason why it is impossible to study those patients the way you are suggesting.

Dr Louagie: My question was the predictive risk factors for recurrence.

Dr Melo: No, and I think it is too early because we are still concerned with transmurality and continuity of the lesions. I believe there is a lot of work to do to improve these results. And the first reason in my mind for failures is that the thickness of myocardium is different from patient to patient, from disease to disease, and we are applying those methods using the criteria I showed of 30 s to reach 70°C temperature. I think there is a lot of work to do in order to make sure that when we are applying those lesions, they are transmural and continuous.

Dr Louagie: Regarding an electrophysiological study, I mean an intraoperative mapping. Did you perform intraoperative mapping to map the atrial fibrillation?

Dr Melo: No, we did not.

Dr O. Alfieri (Milan, Italy): Do you really think that transmurality of the radiofrequency lesion is essential in order to obtain a good result? There is some experimental evidence that it is not so. Although your method of treating atrial fibrillation in mitral valve disease is attractive and simple, in my opinion things can be further simplified. At the San Raffaele Hospital in Milan, we do what you do applying radiofrequency from outside, encircling the right pulmonary veins before cardiopulmonary bypass and the left pulmonary veins using partial cardiopulmonary bypass. In doing so the time of aortic occlusion is not increased and probably the danger of thromboembolism is reduced. What is your opinion on this alternative technique?

Dr Melo: It is difficult for me to understand that we have been for the last 6 or 7 years involved in the treatment of atrial fibrillation and doing transmural surgical incisions and now to realize that may be not important, but to me it looks much safer to ensure that there is transmurality. Even though some people are inducing atrial fibrillation in pigs with different procedures, which in my mind have no relation with atrial fibrillation in human beings, either mitral or lone atrial fibrillation, I am quite cautious about the experimental models of atrial fibrillation. So it is reasonable to make transmural lesions, and of course it is highly reasonable to do epicardial lesions. But, again, to do those epicardial lesions, I think we have to realize that the biophysical behavior of those applications is completely different from the endocardial. So we are searching for the ideal settings for the epicardial applications.

Dr R. Benetis (Kaunas, Lithuania): Atrial fibrillation remains one of the most important arrhythmias in a set of patients with mitral valve disease. There is some data showing that even without any kind of antiarrhythmic procedures after mitral valve repairs or mitral valve replacement, there is a restoration of sinus rhythm spontaneously, in up to 40% of patients. Do you have any data comparing your procedure with just a simple mitral valve procedure? And another question is regarding the radiofrequency ablation technique. As I understood from the last question and answer, you are looking for some other techniques to be applied for isolation of the pulmonary veins, actually the muscle going into the pulmonary veins, and in some papers it has been shown up to 4, 5 cm deep into the lungs. Have you ever tried cryoablation, which is a short, fast technique?

Dr Melo: Regarding your first question, in all our published papers and procedures we have been treating always chronic atrial fibrillation. Before starting those procedures, we have reviewed 600 patients we have operated on in the previous 6 years, and we have found that if patients have atrial fibrillation for over 1 year, the likelihood of spontaneously recurring to sinus rhythm was 8%. So only 8% of our results are attributable to spontaneous recurrence, and that is why I am very cautious when I see reports of patients with paroxysmal atrial fibrillation or early atrial fibrillation. We are very cautious about cryoablation, for several reasons, the most important reason being that when we performed the maze operation in mitral patients, we were surprised with the number of patients who were still in atrial fibrillation, and that was the maze I, or the maze III, that had 25% of patients still in atrial fibrillation. In bench work we have realized that when you apply cryoablation in thick myocardium, it is not transmural. Atrial fibrillation surgery with this procedure can be done in a very fast way, and I can see no reason at the moment not to do it in all patients, because with radiofrequency, it is safe, is 60% efficient. I do not know what is better for a patient, to have silent atria or to have resection of the atria. So we may be harming 10% of our patients by leaving them with some silent left atria, but only time will tell.