**EDITORIAL COMMENT**

**Lone Atrial Fibrillation Ablation**

Transcatheter or Minimally Invasive Surgical Approaches?*

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Atrial fibrillation (AF) is the most frequent supraventricular arrhythmia, and its therapy is still unsatisfactory. Different theories have been proposed to explain its mechanism. Nowadays it seems well accepted that both focal and re-entrant mechanisms are involved, playing a different role in the initiation and maintenance of the arrhythmia. Moreover, the importance of each mechanism varies in patients with different etiologies of the arrhythmia. The presence of atrial foci functioning as triggers, generally localized in the pulmonary veins (PVs), is the main finding in patients with lone or idiopathic AF. In this patient population, the focal ablation of AF has been shown to be quite effective. In contrast, in patients with chronic AF and valvular heart disease associated with concomitant pathologic atrial modifications, the ablation of the atrial foci is less effective. It seems reasonable to suppose that in patients with chronic AF an abnormal substrate with short and nonhomogeneous conduction properties plays a more important role than the trigger foci.

On the basis of these clinical results, in patients with paroxysmal lone AF, transvenous catheter ablation of the foci with the electrical isolation of PVs has been proposed as first-line nonpharmacologic therapy. In contrast, in patients with permanent AF and/or associated heart disease (especially valvulopathies with enlargement of the left atrium), surgical linear lesions are generally performed with the aim to modify the electrical substrate.

Kottkamp et al. (1) proposed a surgical linear approach in patients with lone AF without any other indication for cardiac surgery, and the risk/effectiveness ratio of this minimally invasive surgical approach was evaluated.

Cox et al. (2) was the first to demonstrate the possibility of a cure of AF by means of bialtral linear incisions (Maze procedure). This procedure aims to reduce the electrical critical mass and to create conduction barriers that prevent the circulation of the re-entrant atrial wavelets. Although quite effective, the Maze procedure is a very complex operation requiring a long procedure time and is associated with complications (2). For this reason, various limited surgical and transcatheter techniques have been designed that relate to the modification of the substrate rather than to reduction of the critical mass.

In most surgical techniques the main objective is to create limited linear lesions in the left atrium (3–6), although in some cases isolation of the PVs becomes the principal aim (7,8). These approaches have been attempted mostly in patients with valvular heart disease and permanent or paroxysmal AF. The success rate has varied from 60% to 90% depending on the type of the lesion scheme utilized and the population studied. It is noteworthy that the posterior sections of the left atrium and the ostia of PVs were involved in all cases despite the different energy sources used (radiofrequency [RF] or cryoenergy) and the different design of the intended lesion. These results imply that the posterior part of the left atrium is crucial in the genesis and maintenance of AF. Atrial activation during AF is not spatially homogeneous, and regions with more or less disorganized activation usually coexist in the same patient (9,10). The posterior left atrium represents a region with a high degree of disorganized atrial activity and seems to be critical in the maintenance of the re-entrant fibrillating wavelets.

Reviewing the data from the clinical studies published, it is still unclear which is the predominant effect of ablation. Is the clinical success due to the modification of the substrate by linear lesions or to the abolition of atrial foci inside the PVs or both? The study by Kottkamp et al. (1) does not completely clarify the issue. In fact, the ablation target was the elimination of left atrial macro-re-entrant “anchor” circuits utilizing linear lesions. However, the ablation probe was inserted a few millimeters inside the PVs. As it is known (11) that PVs may sometimes be electrically isolated with only few RF deliveries, it is evident how much difficult it is to claim the results are due to the “pure substrate modification” or to elimination of the triggers to some extent. Intra- or postoperative mapping assessing the possible presence of atrial foci inside PVs or their electrical isolation would have been useful to clarify the issue. This is particularly important because it has been shown that in this type of population most of the patients present lone AF in which the triggers usually play a more prominent role.

The work of Kottkamp et al. (1) examined a patient population in which the only indication for surgery was AF resistant to drug therapy. A minimally invasive surgical technique was used in order to reduce the risks of the surgical procedure. Surgery with video-assisted images allows the surgeons to perform surgery on lesions in exact, specific areas. It should prevent gaps of conduction in the ablation lines owing to the good contact between the probe and the atrial tissue, solving in such a way one of the most difficult problems encountered with transvenous catheter

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ablation. However, even under direct vision, gaps were present in at least three patients who needed RF ablation to terminate atypical left atrial flutter.

As in previous surgical reports (3–8) the success rate is quite high, and almost all the patients maintain stable sinus rhythm after the ablation procedure. In some cases, however, drug therapy remains necessary. It is interesting to note the difference between patients with paroxysmal and permanent AF in the clinical follow-up. The overall success rate is similar between the two groups, but in the latter group a higher number of patients still needed drug therapy to maintain sinus rhythm. The drug-free patients were about 55% in the permanent group and 83% in the paroxysmal group. This clinical evidence also supports the concept that in patients with paroxysmal and permanent AF, the mechanisms and the substrates underlying the arrhythmia are probably different, as shown by endocardial atrial activation mapping (10).

The success rate of this surgical approach (95%, with the additional use of drugs in some cases) is higher than the success rate reported with transvenous linear ablation limited to the right atrium (12,13) or performed in both atria (13–15). However, these results are only slightly better in terms of maintenance of sinus rhythm than what is described in patients who underwent PV isolation (11,16). This latter technique evolved over the last five years. At the beginning, the aim was to localize the vein responsible for the AF initiation, and the ablation was performed inside the vein where the triggering foci were localized (17). With this approach a high incidence of recurrences was reported because of the presence of different foci in the other PVs. More important, a high incidence of complications, such as PV stenosis, was described. This was attributed either to the amount of energy used or to the delivery of the energy inside the vein. Today the technique has been modified: electrical isolation of all four PVs is usually performed, and the RF energy is generally delivered as much as possible proximally to the ostium in order to reduce the risk of stenosis. The electrical PV isolation can be accomplished either with a mere anatomic approach (18,19) or with an electrically guided approach (11). In the latter case the ablation is limited to the vein section where the muscular strands connect to the atrial myocardium. In such a way the electrical isolation can be obtained with a fewer number of RF deliveries, leading to a theoretical reduction of complications, especially PV stenosis, thus maintaining a high success rate of about 85% (11).

Considering that at the present time in the patient population considered (lone AF) the minimally invasive surgical approach shows only a slight benefit over the transvenous approach, the clinician should suggest the treatment with the best risk/benefit ratio. With the surgical technique proposed by Kottkamp et al. (1), the risks related to sternotomy are not present. Moreover, cardiac tamponade and PV stenosis have not been described. Still, the procedure is not completely free of complications. In fact, 2 patients out of 70 suffered from major complications. One patient developed symptomatic circumflex coronary artery stenosis related to the use of RF energy in close proximity to the course of the artery. A second patient had esophageal perforation with septicemia. This complication is related to the possible conduction of the heat generated by RF energy outside the intended operative field and may have fatal consequences as reported by other investigators (20).

The incidence of complications may be reduced either with technical methods as suggested by the researchers or by using a different energy source, such as cryoenergy. Cryoenergy produces a lesion that generally preserves the integrity of adjacent structures (particularly of the vessels) (21). In a previous report (5) no damage of adjacent structures and particularly of the esophagus was reported. In addition, owing to the preservation of the collagen tissue, no risk of perforation and consequent fistula is present, even in cases of damage to adjacent structures.

In summary, the study by Kottkamp et al. (1) clearly confirms how linear lesions in the posterior part of the left atrium connecting the PVs and the mitral annulus are effective in curing AF in most patients with or without associated heart disease. The surgical approach, however, is still ineffective in some patients, and in more than one-third of patients with permanent AF, drug therapy is still necessary to maintain sinus rhythm. Possible explanation may be either the fact that the ablation lesions are not deployed in the right areas or that the lesions are not transmural or are incomplete. A postprocedure extensive electrophysiologic evaluation confirming the completeness of the lines of conduction block and its correlation with clinical results may provide an answer to these questions. Despite its complexity, this electrophysiologic mapping has been attempted after transvenous catheter ablation, looking for lines of double potentials (22) or of conduction block with nonfluoroscopic navigation system (CARTO, Biosense Webster) (14,15). At the present time no data are available in patients who underwent surgical ablation of AF.

The presence of gaps along the lines of ablation has been demonstrated in the patients who developed left atrial atypical flutter (1). It can be hypothesized that in patients who need antiarrhythmic drugs to prevent AF recurrences, the ablation lines still present some conduction gaps or they are not transmural.

The success rates of surgical and transvenous ablation are similar even if it seems slightly in favor of surgery. However, complications have been described in both cases. This must be clearly kept in mind when choosing an approach. In fact, the success rate and the morbidity and mortality of the procedure and the morbidity and mortality associated with the disease for which the treatment is proposed must be carefully evaluated.

Finally, both the knowledge and the success rates of AF ablation, surgical or percutaneous, have greatly improved over the last decade, with a substantial reduction of the complications related to the procedure. But these compli-
cations still occur and are not trivial. Therefore, we should conclude that today an optimal approach for AF ablation is not yet available. In fact, considering the relative benign nature of AF, the "optimal" ablation technique should present not only a high success rate but, above all, a very low risk of complications.

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REFERENCES