

Why are the hybrid “off-pump” procedures to surgically treat the stand-alone atrial fibrillation not working well?

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Key words: Atrial Fibrillation; Atrium; Arrhythmia; Cox-maze procedure; Stand-alone atrial fibrillation.

Palabras clave: Fibrilación auricular; Aurícula; Arritmia; procedimiento de Cox-maze; Fibrilación auricular aislada.

Cir Card Mex 2021; 6(4): 84-6.

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According to statistics from the STS National Database, between July 1, 2011 and June 30, 2014, 13.4% of cases underwent cardiac surgery had preoperative AF. Of the cases selected for surgical ablation (SA) of AF, only 48.3% underwent SA for AF. Out of them, 96.7% were cases of concomitant AF, and the remaining 3.26% were cases for stand-alone AF [1]. This can proportionate a general overview about the SA for AF nowadays. Moreover, the most frequent underlying pathology associated to concomitant AF was the mitral valve disease in the full range of its possibilities such as single, with/without CABG, with/without aortic valve disease [1].

The 2017 STS guidelines for the surgical management of AF clearly point out a recommendation class I (COR) level of evidence (LOE) A in the case of mitral valve disease and B for cases other than mitral valve disease, such as aortic valve disease or coronary artery disease both of them as the primary cardiac pathology demanding cardiac surgery [2]. Nevertheless, in the case of stand-alone AF with symptoms, refractory to antiarrhythmic drugs, or after failed catheter-based therapy, the recommendation is COR IIa, LOE B. In addition, for cases of persistent or long-standing persistent stand-alone AF is recommended using the same full bi-atrial lesion pattern as in the Cox-maze IV, COR IIa, LOE B [2].

This is the framework within which we have to work, with all these concepts at once. At the time of keeping in mind that stand-alone AF represents a relatively low number of cases for SA for AF, in one way or another the incessant flow of information towards less invasive procedures has diverted the attention of electrophysiologists towards these types of procedures. Much to our dismay, this is where our drama has

started. There is a totally wrong perception about the effectiveness as well as the morbidity and mortality related to the “on-pump” procedure. Specifically speaking about the endocardial Cox-maze procedure as a way of performing minimally invasive surgery for the Cox-maze procedure, Jiang et al. [3] have demonstrated that there is no important difference in morbidity or mortality when comparing the Cox-maze procedure made through a median sternotomy to the endocardial Cox-maze procedure performed by means of a right mini thoracotomy. Not only the efficacy but the safety of the procedure as endocardial Cox-maze procedure has been well demonstrated by Ad et al. [4], with no important differences in terms of morbidity or mortality, with an overall freedom from AF up to 90% at 5-years follow-up. In this series of 133 consecutive patients, there were no conversions to mid sternotomy, no renal failure, strokes, or operative mortality. Thus, although no direct comparison, this is a clear demonstration that even a greater success has been achieved with this “on-pump” technique than for catheter ablation or “off-pump” surgical ablations reported in the literature [4]. That means to say that the medical community and patients should be reeducated at this regard.

Ever since the seminal paper by Haisaguerre et al. [5], the cornerstone of the surgical ablation procedures has been the pulmonary vein (PV) isolation. In fact, this work demonstrated up to 90% of times the triggers initiating AF are located into and around the PVs. However, we should not lose sight two critical aspects of this investigation. On one hand, most of the cases reported in this article had paroxysmal AF. Thus, this concept is not valid for cases other than paroxysmal AF. On the other hand, these triggers producing AF are located into and around the PVs. Around means chiefly left atrial antrum. In fact, a very recent article has shown the importance of isolating not just the PVs, but the whole PV-antrum complex [6]. This fact has come into action as one of the most

challenging situations for “off-pump” surgical ablations of AF. The challenge to get a complete transmural ablation around the PV-antrum complex is such that several methods to perform the box lesion set have been described [7]. However, shall we analyze one by one the most important facts limiting the effectiveness of the procedure.

In performing the Cox-maze procedure, the only two alternative energy sources that have been proven in getting a consistent full transmural ablation are the bipolar radiofrequency ablation and cryoablation. Other than these (including the monopolar radiofrequency) should be avoided for the daily practice [8-10]. The cryoablation has positively revolutionized the scenario of the arrhythmia surgery in terms of getting full transmural ablation in the burn lines. Success rates up to 95% in recovering sinus rhythm have been reported [11]. Moreover, it has been suggested the superiority of the cryoablation over the bipolar radiofrequency or even the combination of bipolar radiofrequency in combination with cryolesion [10-12]. Now, on a beating heart, the main issue is the rewarming from the bloodstream and the inherent constant movement of the heart, two important limitations with the cryoprobe. Bipolar radiofrequency ablation is the most useful tool for the PV isolation on both sides. Hence, the full transmural ablation around the PV is guaranteed. Working by bilateral or unilateral approach using only videoscopes is the medullary aspect of this type of techniques. However, the real problem lies on the great difficulty to create both connecting lines at the floor and roof of the left atrium. Given the fact the bipolar clamp cannot be placed to get these connecting lines, the most commonly used is a device delivering “bipolar” radiofrequency as unidirectional but not bidirectional as in the bipolar clamp. As a result, the inconsistency of the full transmural ablation in these connecting lines is too high, 34% and 60% of success for the roof and floor lesions, respectively [13]. With the other kind of tool by applying vacuum through a ribbed probe placed around the PV, the same problem about the inconsistency of the full transmural ablation is often observed [14]. In this sense, by adding the endocardial approach to the previous epicardial one we can get the hybrid approach. Indeed, this hybrid approach entails both, epicardial and endocardial approaches. The hybrid approach came to light in order to improve the imperfect results of the “off-pump” techniques to treat the stand-alone AF. This might be the solution as long as provided it is adhered to the principle of the Cox-maze procedure as the full bi-atrial lesion pattern [15].

The reiterative problem with the hybrid procedure is the inconsistency in the pattern of lesions (modified because of the impossibility of accessing all the anatomical sites involved while ensuring a true transmural ablation). Thus, we have begun to see all the varieties of mazes that are not true Cox-mazes [16]. As a result, a frank detriment to the Cox-maze performance is frequently observed with the hybrid procedure as low as 56% from freedom of AF at 1.5 years of follow-up for non-paroxysmal AF cases [14, 17].

By the same reason, most of the times, the right-sided lesions are untreated as a part of the hybrid procedure. To the best of our knowledge, there are up to six macro reentrant circuits that have been described which can sustain AF in the

right atrium [18]. Therefore, on the grounds previously laid down above, the three lesions on the right atrium are totally necessary as a part of the procedure. If they are missed, the likelihood of recurrence of the AF may be as high as 20%.

Additional lines such as the mitral line are an essential part of any Cox-maze procedure. This line is a very sensitive lesion since it involves several specific details; namely, it is preferably performed in an area free of coronary arteries (since radiofrequency and cryo can injure them) [19], it involves the floor of the left atrium until reaching the mitral annulus, it must be performed from inside the heart because the overlapping left ventricular wall over the left atrial (otherwise, it becomes impossible to reach full transmural ablation because of the excess fat tissue overlapped in the area near the mitral annulus), and finally it also involves two cryothermia application sites on the mitral annulus (inside the heart) and on the coronary sinus (on both sides of the heart). There are some muscle fibers crossing over the coronary sinus from outside the heart that can conduct the electric impulse from one atrium to the other, sustaining the perimitral flutter that can be seen in the postoperative period after the Cox-maze [20].

There is no room for changing this mitral line for any other pattern. The “Dallas lesion” set was proposed as an alternative to the mitral line. However, since the Bachman bundle is burned or even sectioned in the Dallas lesion set, an important delay of 40 milliseconds in the intraatrial electrical conduction is observed in a similar way as was seen in the Cox-maze I and II. As a result, important dysynchrony is observed resulting in activation of the left atrium at the same time as the left ventricle. Therefore, there is a loss in the transport function of the left atrium [18]. Unfortunately, this variation using a burn line on the atrial trigone similar to the “Dallas lesion” is too often seen in the off-pump epicardial surgical ablation procedures for stand-alone AF [21,22].

At last but not least, the left atrial appendage (LAA) management is another issue of great concern in the course of the hybrid procedures. Since the very beginning, the LAA exclusion has been described as a part of the Cox-maze procedure [23]. It has been demonstrated the utility of resecting the LAA in reducing the stroke rate after procedure. In general terms, the stroke rate is less than 1% after operation. Withlock et al. [24] demonstrated the utility of excluding the LAA in patients having AF (with no Cox-maze procedure). In this randomized study, 4.8% in the occlusion group and in 7.0% in the no-occlusion group (hazard ratio, 0.67; 95% confidence interval, 0.53 to 0.85; $P = 0.001$) had a postoperative stroke. Similar findings were reported by García-Villarreal et al. [25]. 2017 STS guidelines for the surgical treatment of AF recommend as Class IIa, LOE C the excision or exclusion of the LAA during the course of the Cox-maze procedure as well as a part of any open-heart surgery in patients with AF, for longititudinal thromboembolic morbidity prevention [2]. Of great concern is the fact that according to the STS National Database, in a period of time between 2014 and 2017, regarding the “off-pump” surgical ablations, only the 55% had a true LAA occlusion [26]. This is a quite too disturbing fact, since LAA is the main source for thrombus formation in patients having

AF. This same fact acquires special importance in terms of stroke, considering that the half of these patients exhibit some recurrence of the AF after the procedure [14].

In the light of the foregoing, it is not surprising the results after the hybrid procedure are not as good as expected, ranging as a whole between 56% and 78% at 1-2 years of follow-up.

For all of these reasons listed in this writing, the hybrid procedure to treat the stand-alone AF is not working as well as expected. The results of converting an “off-pump” epicardial surgical ablation towards a hybrid procedure are questionable because most of the time the authors are eliminating one or more of the burn lines originally described in the pattern of the Cox-maze IV procedure. Thus, the fundamental problem remains dual: inconsistency to achieve perfect isolation of the PV-antrum complex in terms of full transmural, and the using of lesser procedures which are not true Cox-maze procedures. Meanwhile, whatever the cause may be of each difference between observed and expected results with the “off-

pump” lesser procedures, we have reason to believe the only viable and plausible alternative that has been shown to have consistent results in terms of freedom from AF in the long term is the endocardial Cox-maze as minimally invasive “on-pump” procedure [27]. The medical community, especially electrophysiologists as well as cardiac surgeons, should be reeducated to take the necessary measures and act upon the facts at our hands as of yet. The endocardial Cox-maze procedure represents the most effective technique even for the stand-alone AF, and it should not be ruled out as first option to surgically treat the stand-alone AF in our daily practice.

FUNDING: None

DISCLOSURE: The author has no conflicts of interest to disclose.

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