Understanding the atrial fibrillation substrate: the case for repeat catheter ablation

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Received 24 February 2014; accepted after revision 19 March 2014; online publish-ahead-of-print 28 April 2014

This editorial refers to ‘Predictors of recurrence after a repeat ablation procedure for paroxysmal atrial fibrillation: role of left atrial enlargement’ by R.-B. Tang et al., on page 1569.

Radiofrequency catheter ablation has become a curative treatment for some patients with symptomatic drug refractory atrial fibrillation (AF).1 However, adequate selection of candidates for catheter ablation is important because of the potential, albeit infrequent, complications of the procedure (incidence reported in up to 4% of procedures), its costs, and the non-negligible rate of recurrence of the arrhythmia (up to 40%) even in experienced hands.2 In fact, one of the main limitations is our poor understanding of the real substrate underlying AF.

Cardiac remodelling develops in response to myocardial contractile dysfunction to maintain stroke volume or to adapt to changes in overload. The atrium is not an exception, and atrial remodelling originates from the mechanical effects on the atrial wall, such as direct chronic volume overload (for instance, mitral regurgitation) or indirect chronic overload induced by elevated filling pressures (as is the case of dilated or hypertrophied left ventricles). The remodelled atrium finally acts as the necessary substrate for the initiation and perpetuation of AF.

Remodelling includes the distortion of normal geometry, enlargement of the cavity, and substitution of the normal tissue by collagen or fibrotic tissue. Consequently, different parameters can be used as indicators of remodelling. With the aim of characterizing the atrial substrate, different approaches have been proposed to assess atrial remodelling, particularly to identify the best candidates for catheter ablation of AF. Several studies have described the relationship of atrial enlargement and the lower likelihood of successful ablation of AF.3

A study in 148 patients using M-mode and two-dimensional echocardiography4 has shown that an anteroposterior left atrium (LA) diameter ≥ 45 mm was an independent predictor of the absence of recurrent AF after ablation. Similarly, LA area < 34 mL/m² predicted the absence of recurrent AF.5 Using computed tomography, LA volumes < 145 mL have also been related to successful ablation of AF.6 More recently, analysis of LA shape (sphericity index) has shown promising results in selection of patients with less advanced atrial disease who may be more suitable for catheter ablation.7

Analysis of LA function either by three-dimensional8 or myocardial deformation ultrasonic imaging9,10 has provided additional information on top of LA size for understanding remodelling and identifying adequate candidates for AF ablation. Impaired LA function is related to lower success of ablation, with higher sensitivity and specificity compared with the assessment of LA size, particularly in the setting of a mildly dilated LA, which is generally found in patients referred for ablation.

Finally, direct quantification of myocardial fibrosis content in LA by delayed enhanced magnetic resonance has been related to success of catheter ablation in eliminating AF.11 The incidence of AF recurrence was 14% in patients with minimal enhancement, 43% in those with moderate enhancement, and 75% in those with extensive enhancement.12,13

Despite compelling progress in the identification of factors related to success of ablation after the first procedure, scarce data are available regarding LA characteristics in patients undergoing repeat procedures. Several studies have shown that LA size decreases after ablation without a significant impairment in LA function. A meta-analysis confirmed these findings, suggesting that the successful elimination of the arrhythmia by ablation induces reverse LA remodelling which in turn counteracts the potential negative effect of atrial scarring due to the ablation lines.15 These observations also highlight the unique atrial substrate in patients who have already undergone an ablation procedure for AF and need a repeat procedure; this substrate includes both changes in response to the ablation lines (scarring) and remodelling due to the arrhythmia and underlying atrial myocardial disease.

In a previous study, LA size and LA function assessed by two- or three-dimensional echocardiography failed to predict AF recurrence after the second ablation procedure4 underscoring the fact that this could be due to a different atrial substrate. More recently, the potential of myocardial deformation imaging to identify best candidates for...
repeat procedures has been proposed, with patients with significantly reduced LA strain parameters having lower rates of arrhythmia elimination after repeat ablation (percutaneous or surgical).  

In view of the current evidence, Tang et al. are to be commended for their new approach emphasizing the role of changes in LA size after first ablation. In this issue of the Journal, they report on 95 patients who were divided into two groups depending on the change in LA diameter between the first and repeat ablation procedures. The incidence of AF recurrence after the repeat procedure was 51% in 35 patients in whom LA size increased compared with 25% in 60 patients without an increase in LA diameter. Other risk factors such as the type of AF or LA diameter did not differ between patients with or without recurrence of AF after the repeat procedure. The latter highlights the fact that the atrial substrate in patients undergoing a repeat procedure is different from that in patients undergoing their first ablation. Apart from being the first study that deals with echocardiographic predictors of successful repeat ablation for AF, this report describes an easy approach with universally available measurements based on M-mode or two-dimensional echocardiography without any added risk to the patient or unaffordable costs. If confirmed in further larger studies, this approach may improve the management of these patients.

While the exact cut-off or the precise parameter (LA anteroposterior diameter, volume, strain, etc.) may vary slightly between studies, the concept of assessing LA substrate in terms of LA size, shape, or function should be undoubtedly taken into account when considering ablation for AF. Potentially, a more comprehensive analysis integrating the interplay among all these parameters could provide an adequate tool for better selection of patients on an individual basis and consequently could improve the outcome of therapy in the era of personalized medicine. As the knowledge of pathophysiology progresses, an improvement in therapies, which are in turn consolidated by technological developments, should be reached. However, although technological advances are associated with improved safety, if they are not applied to the right patient, they will not ever work properly.

Conflict of interest: none declared.

Funding

This work was partially supported by a grant from ‘Plan National I + D + I’, Spanish Government (no. DEP2010-20565).

References