Will my ablation work? Check the P-wave

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This editorial refers to ‘Value of P-wave signal averaging to predict atrial fibrillation recurrences after pulmonary vein isolation’ by C. Blanche et al., on page 198–204

Despite recent advances in both our understanding and therapy of atrial fibrillation (AF), this arrhythmia continues to challenge our ability to effectively and permanently restore and maintain sinus rhythm. Antiarrhythmic drug therapy is ineffective for many patients and, despite early enthusiasm, radiofrequency ablation is characterized by recurrence of the arrhythmia and the need for repeat procedures.1

It is appreciated, however, that some patients with AF do better than others after ablation. Clinical predictors of benefit include age, persistence of AF, and markers of structural change such as left atrial enlargement.2 It is recognized that in patients in whom these factors are adverse, modification of the left atrial substrate might be important in addition to isolation of the pulmonary veins and that substrate modification can improve outcome.

Nevertheless, any practising electrophysiologist will recall instances where patients with an apparently good predicted outcome will respond poorly to AF ablation and others where outcome is much better than one would expect. Marrouche and coworkers2 have recently identified that the response to AF ablation may have more to do with the underlying atrial substrate, as judged by the magnetic resonance imaging (MRI)-derived fibrosis score, than clinical factors, such as persistence of AF. Patients with a high fibrosis score of >35% did not respond to ablation although some presented with lone and/or paroxysmal AF. Conversely all patients with a low fibrosis score (<5%) responded to catheter ablation regardless of their pattern of AF. While these data underscore the importance of the left atrial substrate in patients undergoing AF ablation? This question has implications for the pathogenesis of AF, as well as in predicting the ability for current catheter ablation techniques to influence outcome, analysis of the fibrosis score using MRI technology can be time consuming and costly, suggesting that an alternative bedside measure may be desirable.

Analysis of the signal-averaged P-wave (SAPW) is a well-established technique that is yet to establish a clear clinical role. Its utility as a predictor of AF in a variety of clinical settings has been investigated.3 In general, these and other studies have identified that, in whatever scenario, patients that are likely to develop AF have longer P-waves, increased P-wave energy (or amplitude) and increased P-wave dispersion. Similar findings are apparent when the risk of recurrent AF after cardioversion or after cardioversion from short- or long-term AF is studied.3

Despite these promising findings, the technique has never achieved sufficiently high positive and negative predictive accuracies to be clinically useful for an arrhythmia that is not, at least in the short term, life threatening.

If the SAPW cannot be used as an accurate risk stratifier, can its analysis tell us something of the underlying atrial substrate? A number of investigators have documented changes in the surface P-wave in response to antiarrhythmic drug interventions, postulating that the P-wave parameters that change must relate in some way to the known electrophysiological effects of the drug. Thus, Sotalol reduces SAPW energy suggesting that this parameter may reflect refractoriness. Pilsicainide alters P-wave dispersion in patients that respond to this drug.3 Attempts to relate simultaneous measurements of P-wave parameters with invasive measures of atrial electrophysiology, despite methodological limitations, have suggested that P-wave duration and low-frequency energy (analogous to amplitude) reflect conduction velocity, whereas high-frequency energy may be inversely related to refractoriness.1,5

So, could analysis of the SAPW tell us anything about the atrial substrate in patients undergoing AF ablation? This question has fuelled the latest research efforts within this field. A number of authors have investigated the SAPW in patients after successful ablation of supraventricular tachycardias, finding that P-wave duration tends to be longer in patients who subsequently develop AF.6,7 Others have reported that P-wave duration is shortened by pulmonary vein isolation (PVI), predominantly by abbreviation of the terminal low-amplitude portion, and that the degree of P-wave shortening can predict those patients in whom the procedure is successful in preventing subsequent AF.8,9 These data are of interest in that they do confirm that analysis of the SAPW can reflect changes to the atria induced by ablation and that the technique can differentiate with reasonable fidelity between changes sufficient to prevent AF and those that are insufficient.

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In this issue of the journal, Blanche et al.\textsuperscript{10} add to these data by reporting the effect of fairly ostial PVI on the SAPW. Their report, in a large series of unselected patients, confirms previous findings that in patients who developed recurrent AF had longer post-operative P-wave durations than those who did not. A longer post-operative P-wave duration was moderately predictive of recurrence. Interestingly, patients with persistent AF also had a longer SAPW duration than those with a paroxysmal arrhythmia.

These data taken in context are reminiscent of the early days of P-wave research where we attempted to predict AF in individuals at risk of the arrhythmia. The predictive accuracy of the technique was not sufficiently high to be of use in planning treatment in an arrhythmia where patience and monitoring could achieve the same end results with a much higher predictive accuracy and at minimal risk to the patient. In the context of the patient after AF ablation, it is difficult to imagine how the result of an SAPW performed when the procedure had finished could influence the subsequent management of the patient. I would consider it unlikely that a further procedure would be scheduled on the basis of a long SAPW duration without clinical evidence of recurrent AF. The electrogenesis of the P-wave changes observed has also not been fully explored. Some authors have postulated that longer P-waves after ablation reflect patients in whom PV reconnection has occurred. Others have suggested that longer post-ablation P-waves reflect incomplete antral isolation (Redfearn D, personal communication). However, the current authors report P-wave durations within 4 h of procedures in which PV isolation was confirmed. Could it be that a prolonged P-wave duration after PVI reflects abnormal atrial substrate that is not fully modified by PVI alone? In this case could P-wave duration either before the ablation procedure or immediately after PV isolation (while the patient is still undergoing the procedure) be a useful tool to identify patients in whom substrate modification is likely to be required or indeed in whom PVI is not to be recommended?

Unfortunately, at present data to support this hypothesis is lacking. Two investigators have reported P-wave durations before PVI, finding them to be moderately longer in patients with recurrent AF compared with those without.\textsuperscript{8,9} One of these investigators\textsuperscript{8} analysed P-wave duration immediately before and after ablation, finding that the degree of P-wave shortening was greater in patients with a successful outcome. Despite PV isolation in all patients those individuals who had recurrent AF had no shortening of the SAPW, whereas the average shortening in those with successful outcomes was 8 ms.

Therefore, it seems clear that the SAPW may afford a way of identifying patients in whom PVI alone is unlikely to lead to freedom from recurrent AF. It may be that these patients would benefit from modification of the left atrial substrate in addition to PVI at the outset, or that these patients are simply a group in whom we cannot modify the disease using our current techniques. After nearly 50 years of investigation analysis of the SAPW may yet lead to a clinically useful test. Further analysis of the predictive value of these relevant measurements is required, however, to establish this before we subject our patients to additional left atrial destruction on the basis of P-wave duration.

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**References**


