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Diverging P waves after convergent procedures: What do they mean?

Atrial Fibrillation (AF) ablation procedures have become a common place in clinical practice. Specifically, targeting both paroxysmal and persistent AF with ablation procedures has yielded relatively good success rates and outcomes. Various strategies have been employed to achieve the desired results. These have included various forms of energies such as RF, cryo and Laser. Also, hybrid convergent procedures where both endocardial and epicardial lesion sets are made have been developed to effectively achieve pulmonary vein and posterior left atrial (LA) wall isolation.

Ablation of the posterior wall of the LA is expected to have an impact on the morphology of the P wave on a 12-lead surface ECG. Typically, lead V1 on a 12 lead surface ECG is biphasic in nature. The initial component is positive while the terminal portion is negative. The initial portion reflects posterior electrical forces approaching an anteriorly placed lead V1 as the sinus node lies posteriorly at the junction of the right atrium and the superior vena cava. The later component in V1 typically has a negative deflection as the LA is activated late due to its posterior orientation in the chest. This accounts for the typical biphasic morphology of the P wave in V1.

In this issue, Yang and colleagues [1] described P wave morphology changes in leads II, III, and V1 after patients underwent convergent ablation procedures for both paroxysmal and persistent atrial fibrillation. They noted temporal changes in P wave morphology after successful ablation. Their findings demonstrated that inferior limb leads II and III did not show any significant changes in P wave amplitude, area or duration over time. However, changes in the negative component of P wave were significant. These included a significant reduction in area over 6 months and an initial increase in the amplitude and duration of the initial positive component in V1, followed by a reduction at both 3 and 6 months.

Ogawa et al. [2] demonstrated that patients with no AF recurrence after AF ablation had shorter P wave durations as confirmed by signal averaged ECGs. Kumar et al. [3] studied the effects of hybrid ablation procedures on P wave durations and demonstrated that they were higher pre-procedurally in persistent vs. paroxysmal patients. There was a significant reduction in P wave duration post ablation in both subsets of patients but this difference was greater in persistent vs paroxysmal patients. This difference was maintained in patients who had no recurrence of AF during follow-up.

Ablation of the posterior wall of the left atrium debulks electrically active tissue and makes it electrically silent. As such, the contribution that the left atrium makes to the terminal component of the P wave in lead V1 is expected to be reduced. More extensive ablation of the left atrium such as left atrial appendage isolation would be expected to cause even further reduction in the area of the negative component in V1. However, it should be appreciated that the terminal negative component of V1 is a function of not only the amount of atrial tissue but also a function of conduction times and contribution of opposing forces occurring at other sites. It is a total summation vector of multiple activation wavefronts that are occurring throughout the atrium. As such, slow conduction in the right atrium may contribute to a delayed component that is in opposite direction to LA activation. In this case, the forces subtract from each other. In a similar fashion, if there is significant delay in conduction of the LA after ablation, this can result in unopposed LA forces that can increase or maintain the duration of the P wave. It is conceivable that in patients where total isolation of the posterior wall of the LA occurs, there is no delayed conduction through this tissue and the reduction in P wave duration would imply that complete isolation has occurred. Similarly, if P wave duration has not significantly reduced post ablation, it may signify that incomplete isolation of the posterior LA has occurred, increasing the risk of AF recurrence over time.

The authors in this paper also describe the changes in the initial component of lead V1 that do not persist over time. This can create a challenge in patient presenting with sinus tachycardia as a tall monophasic V1 would mislead one to diagnose an atrial tachycardia arising from the LA. It is conceivable that the opposing forces of LA activation that have some contribution or influence on the late portion of the positive deflection in V1 are lost after ablation, creating unopposed vectors in the RA. This is comparable to left bundle branch block patients where right ventricular activation is

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masked in the initial portion of lead V1 due to the large forces pointing towards the LV.

The findings from this paper have potential implications. P wave duration of the terminal negative portion in lead V1 can decrease after ablation of the LA posterior wall and maintain these changes over time. It is possible that one may be able to quantify the risk of recurrence based on the magnitude of reduction in these forces. This would offer a powerful tool to predict risk of recurrence of AF after undergoing an ablation procedure. Also, understanding P wave morphology changes post ablation would reduce the risk of misdiagnosing patients with atypical atrial flutters, resulting in unnecessary treatments. A large prospective trial comparing such ECG changes to both short and long term outcomes would be valuable to practicing physicians.

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Gopi Dandamudi*
IU Heath Atrial Fibrillation Center, Indiana University School of Medicine, 1801 Senate Boulevard, Suite 4000, Indianapolis, IN 46202, USA

*Tel.: +1 317 962 0500; fax: +1 317 962 0100.
E-mail address: gdandamu@iu.edu

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