# Changing Activation Pattern of the Coronary Sinus during Ongoing Perimitral Flutter

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## Case History

A 68-year-old man without any structural heart disease underwent ablation of persistent atrial fibrillation in 2008 (isolation of 4 pulmonary veins and electrogram-based ablation of the posteroinferior left atrium) and 2009 (left pulmonary vein reisolation and linear ablation of the left atrial [LA] roof with demonstration of bidirectional block). Recently, he was referred for the ablation of recurrent sustained atrial tachycardia (AT) with stable cycle length of 230 ms (Fig. 1A). A steerable decapolar catheter was inserted into the coronary sinus (CS), and an externally irrigated ablation catheter (Thermocool, Biosense Webster, Diamond Bar, CA, USA) was advanced into the LA via the transseptal puncture. On mapping the AT, the activation of CS was observed from distal to proximal direction suggestive of lateral to septal activation of the LA posterior wall. LA anterior wall was activated from septal to lateral direction (Fig. 1B,C). AT was entrained from 2 distant sites, the septal and the lateral LA, with post pacing interval (236 ms) almost equal to tachycardia cycle length (TCL = 230 ms) at both the sites. The diagnosis of clockwise perimitral flutter was established. Ablation of left mitral isthmus was started endocardially. It was followed by epicardial ablation from inside the CS. Fig. 2A–C shows the intracardiac CS recordings at different instances during ongoing ablation of the mitral isthmus. Notably, the distal to proximal CS activation sequence at baseline changed (Fig. 2A) to a vertical sequence (Fig. 2B), followed by a chevron-like activation pattern (2C). What is the significance of changing CS activation pattern during the ablation of perimitral AT?

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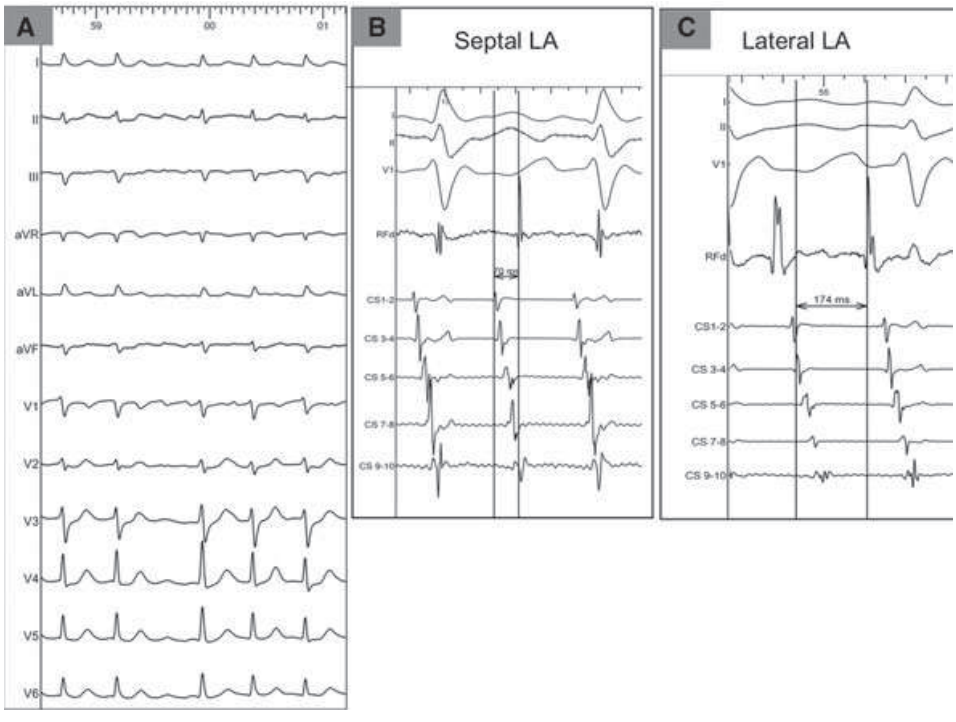


**Figure 1.** *Panel A: Twelve-lead ECG during the tachycardia. Panels B and C show anterior and posterior left atrial activation mapping during tachycardia. Panel B: Anterior-septal site is activated 70 ms from the reference (CS1–2). Panel C: Anterior-lateral left atrial site is activated 174 ms from the reference (CS1–2) suggestive of septal to lateral activation of the anterior left atrium. Activation of CS occurs from distal to proximal bipoles suggestive of lateral to septal activation of the left atrial posterior wall. RFd = mapping catheter, CS = coronary sinus.*

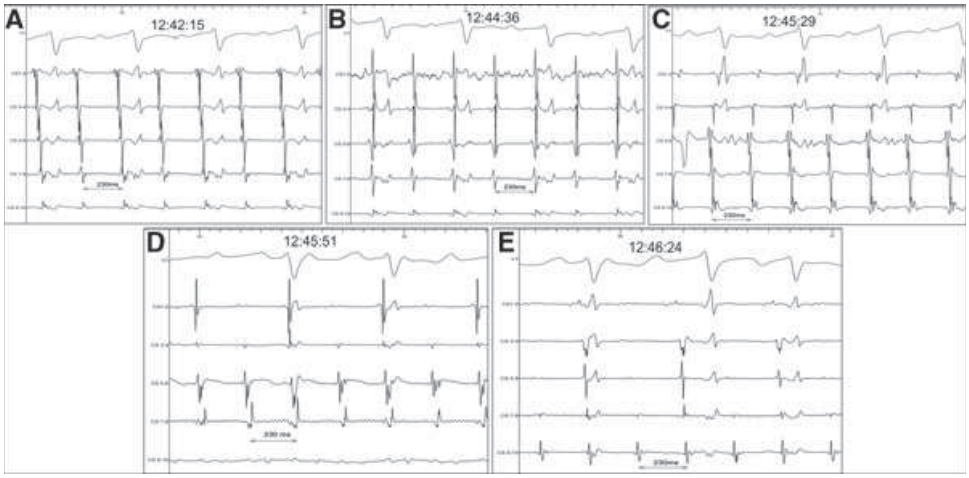


**Figure 2.** *Changing patterns of CS activation noted at different time points (numbers on the top of each panel) during the ablation of perimitral flutter. Tachycardia cycle length remains constant at 230 ms all throughout this period. Panel A: CS activation during atrial tachycardia is from distal to proximal bipoles. Panel B: CS activation pattern changes and becomes vertical. Panel C: Continued ablation further changes CS activation to chevron-like pattern. Panel D: After some more ablation, 2:1 conduction is observed on the distal CS bipoles (CS1–2 and CS3–4). 1:1 conduction continues on the proximal CS bipoles. Panel E: Another 30 seconds of ablation leads to 2:1 conduction on all the CS bipoles except the proximal one. Please note that the size of the CS electrograms in panels 2C and 2E differs from that in the rest of the panels due to movement of the decapolar catheter during ablation inside the CS.*

## Discussion

Left mitral isthmus ablation was started during clockwise perimitral flutter. Progressive ablation at the annular portion of the mitral isthmus (facing distal CS electrodes) resulted in change in the baseline CS activation to a vertical sequence (Fig. 2B) followed by a chevron-like pattern of activation (Fig. 2C). Any change in the CS activation with or without a change in the AT cycle length is often suggestive of a change in the AT. Repeat tachycardia activation followed by entrainment mapping at every moment of change in the CS activation reascertained the original diagnosis of stable clockwise perimitral flutter. This implied that CS was a bystander during perimitral tachycardia and, as against the usual observations, did not constitute the posterior limb of the perimitral circuit. Magnification of the electrograms recorded on the decapolar catheter within the CS (Fig. 2E) was undertaken to decipher the posterior arm of the AT circuit. It revealed smaller far-field LA potentials that could be distinguished from the local/near-field CS signals especially due to changing pattern of CS activation. As shown in Fig. 2, while the local CS activation was changing, the LA endocardium was consistently activated from distal to proximal direction (Fig. 2E) thus forming a stable posterior limb of the perimitral circuit sustaining the original tachycardia. Ablation at the annular portion of the mitral isthmus (both endocardially and epicardially) caused local delay, followed by intermittent 2 to 1 conduction between the posterior LA and the distal half of the CS (Fig. 2D,E) suggestive of partial disconnection of local CS from the rest of the posterior LA myocardium. Eventually, tachycardia was interrupted and bidirectional block across the mitral isthmus was confirmed in sinus rhythm.

Wobbling CS activation followed by 2 to 1 conduction between the LA and CS junction without any change in the tachycardia during ablation prove that CS does not necessarily form a part of the perimitral circuit. Although concentric (proximal to distal/distal to proximal) CS activation is usually observed during perimitral flutter, its absence does not rule out the possibility of macroreentry around the mitral annulus. The CS activation is most often a surrogate for LA activation and after ablation, given variable LA–CS connections, that may not be reliable.[1-3] Ablation at the annular part of the mitral isthmus can cause local delay in the conduction between LA and CS connections altering the activation of the latter that can be interpreted as a change in the original AT. However, an important role of the combined mapping approach involving not only the activation but also the entrainment mapping is emphasized in such a situation. When the CS activation is not concentric and/or changing, a careful analysis of nearfield and farfield electrograms recorded from within the CS or using a detailed endocardial contact mapping of the low posterior LA wall is warranted. If the activation mapping is suggestive of perimitral flutter, it should always be ascertained if the AT is compatible with perimitral circuit by entrainment mapping technique.

## References

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