Ablation as first-line treatment for asymptomatic atrial fibrillation in the context of conduction disturbances: Case report

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Introduction

Atrial fibrillation (AF) is usually associated with a rapid ventricular respons.[1] In this case, 4 periods of 14-day continuous monitoring (Zio patch; I-Rhythm, San Francisco, CA) revealed sinus bradycardia, paroxysmal AF (PAF) with a slow ventricular response, and occasional tachycardia. There was evidence of (1) first-degree atrioventricular (AV) block (prolonged PR interval) and (2) second-degree AV block (Mobitz type I or Wenckebach). The association between sinus bradycardia and AF is well known, the tachy-brady syndrome.[2] Additionally, the association between atrioventricular node dysfunction (AVND) and AF has also been described.[3] This paper discusses these associations and, especially, their implications for considerations regarding treatment options.

A common approach to this clinical situation is permanent pacing, intended to obviate long pauses following AF.[4] Pacing would also allow treatment with antiarrhythmic drugs to reduce the burden of PAF, which otherwise could result in symptomatic bradycardia.

An intriguing question posed by this patient's presentation was whether some or all of the conduction system disturbances were reversible. There is evidence that AF can cause sinoatrial node dysfunction (SAND) and that AF cessation can restore sinoatrial (SA) node function.[5] It is unclear, however, whether AF can cause AVND, which may be reversed if AF is abolished. The recovery of SA and AV function can be explained by the reversal of the effects of AF on cell remodeling and the related obstruction of conductivity.[6] Additionally, the abnormal SA node and AV node function can be explained by excessive vagal tone. This raises the possibility that ablation involving pulmonary vein isolation (PVI), if it includes elimination of the ganglionated plexi (GP) that innervate the SA node and AV node, could reverse the abnormal conduction disturbances and, in turn, obviate the need for a pacemaker.

KEY TEACHING POINTS

- Conduction disturbances involving the sinoatrial (SA) and atrioventricular (AV) nodes seen in atrial fibrillation (AF) may be reversible if the AF is eliminated.
- Excessive vagal tone may cause SA and AV node conduction disturbances, especially in athletes, and especially during sleep.
- Treatment options for paroxysmal AF and AF with conduction disturbances should include ablation before pacemaking. This is because pulmonary vein isolation ablation that includes ganglionic plexi ablation may remove excessive vagal tone and lead to improvement in conduction disturbances.

Case report

The patient is a 78-year-old asymptomatic man with a medical history of mild aortic insufficiency (AI), sinus and AV nodal dysfunction, and paroxysmal AF. In 2010, he was diagnosed with mild AI, and since then, he has been routinely performing exercise stress tests. He continued his annual family doctor visits, during which he had a series of 8 recordings of 12-lead electrocardiograms (ECGs), indicating sinus rhythm, 45–55 beats per minute (bpm), with PR averaging 250 ms, indicating first-degree AV block, and normal QRS, averaging 105 ms, but no AF was found.

In 2020, during a routine stress test, he was incidentally found to have AF with a slow ventricular response. The patient was entirely asymptomatic, and anticoagulation therapy was initiated. He continued to run 3 miles, 2–3 times per week, and reported no reduction in his exercise tolerance. His echocardiogram showed normal left ventricular function (left ventricular ejection fraction, 70%) and size; bicuspid

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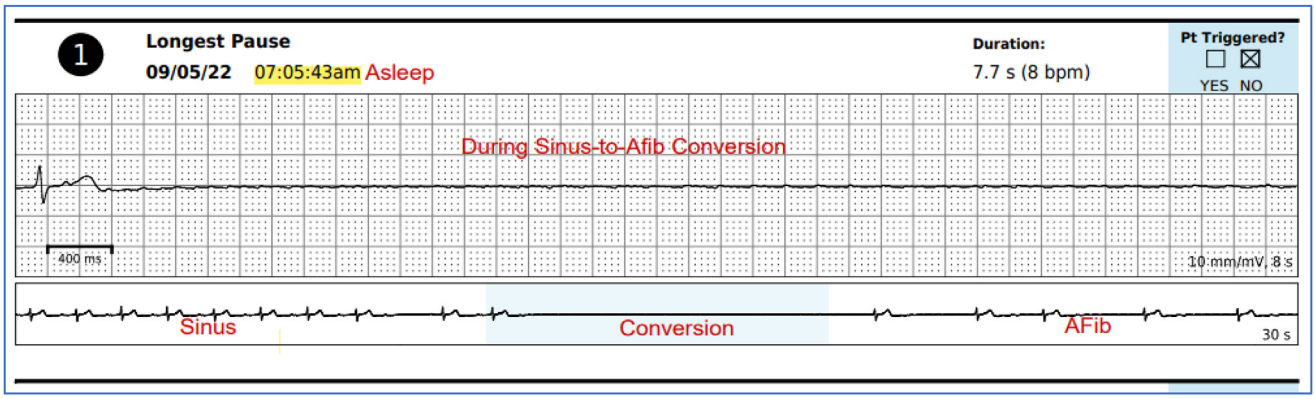

Figure 1 Strip from a 14-day monitoring electrocardiogram taken preablation at night, showing a long pause (7.7 seconds) during conversion from sinus rhythm to atrial fibrillation.

aortic valve without significant stenosis; mild AI; and a normal-sized aortic root.

Since he was diagnosed with PAF, he underwent 4 14-day cardiac ECG rhythm monitoring sessions performed over the subsequent 2 years, all of which revealed PAF with 35% burden and a slow ventricular response ranging from 40 to 50 bpm, and acute complete AV block on conversion from sinus rhythm to AF with pauses up to 7.7 seconds during sleep (Figure 1). Occasional episodes of AF with tachycardia were also recorded. During sinus rhythm periods, first-degree and second-degree AV were observed (PR >300 ms and Wenckebach phenomenon or Mobitz type I). Rare episodes of high-grade AV block with dropped beats were also observed. Most episodes occurred during sleep. A relevant ECG strip is shown in Figure 1. The patient was not found to have any reversible triggers of AF, and obstructive sleep apnea was excluded by formal testing. His electrophysiologist was mainly concerned with the long pauses and evidence of AV block and suggested 2 possible follow-up strategies: (1) continued monitoring with no intervention or (2) management with a pacemaker. Subsequent referrals with other electrophysiologists yielded a third option: catheter ablation, based on the assumption that the predominant dysrhythmia was AF.

Recent studies indicate that SAND,[3] and even AVND, may improve if the AF is eliminated or its burden significantly decreased.[4] Initially, the patient preferred continued monitoring, but later opted for ablation when AF was associated with long pauses of up to 7.7 seconds (mentioned above, Figure 1).

Intervention outcome

He underwent PVI ablation on November 10, 2022, using a Medtronic Arctic Front 28 mm cryoballoon (Medtronic, Minneapolis, MN). Because of proximity to PVI, ablation with this device may secondarily ablate the nearby GP, which innervate SA and AV nodes. Thus, the procedure can be considered PVI + GP ablation. All 4 pulmonary veins were isolated and PV potentials were observed using a circular mapping catheter. Complete occlusion was demonstrated by contrast injection. Freezing was applied for 180 seconds and the lowest temperature measured was -45 degrees. The lowest esophageal temperature measured was 34.2 degrees. Pacing demonstrated entrance and exit block present in all 4 pulmonary veins.

Three months later, a 14-day cardiac rhythm monitoring showed an increase in the minimum sinus rhythm, a complete abolition of AF with its associated pauses, and substantial

Table 1 Preablation and postablation 14-day monitoring data

	Zio period	Start date	Number of pauses (>3 s)	Longest pause (s)	AF burden	Longest AF episode (h:min)	Sinus		AF		Comments
							Min (bpm)	Avg (bpm)	Min (bpm)	Avg (bpm)	
Pre	1	1/14/2021	44	4.8	39%	8:37	27	56	22	43	Mobitz I
	2	9/2/2021	178	6.6	37%	9:34	30	57	23	44	Mobitz I
	3	2/18/2022	128	5.4	29%	7:20	42	60	21	45	Mobitz I[†]
	4	8/31/2022	119	7.7	34%	10:34	44	61	21	42	Mobitz I
	Average		117	—	35%	—	36	59	22	44	—
Post	5	1/9/2022	5	3.7	No AF		49	67	No AF		Mobitz I[†]

AF = atrial fibrillation; bpm = beats per minute.

[†]Possible atrial tachycardia with block and nonconducted suraventricular ectopic beat (s).

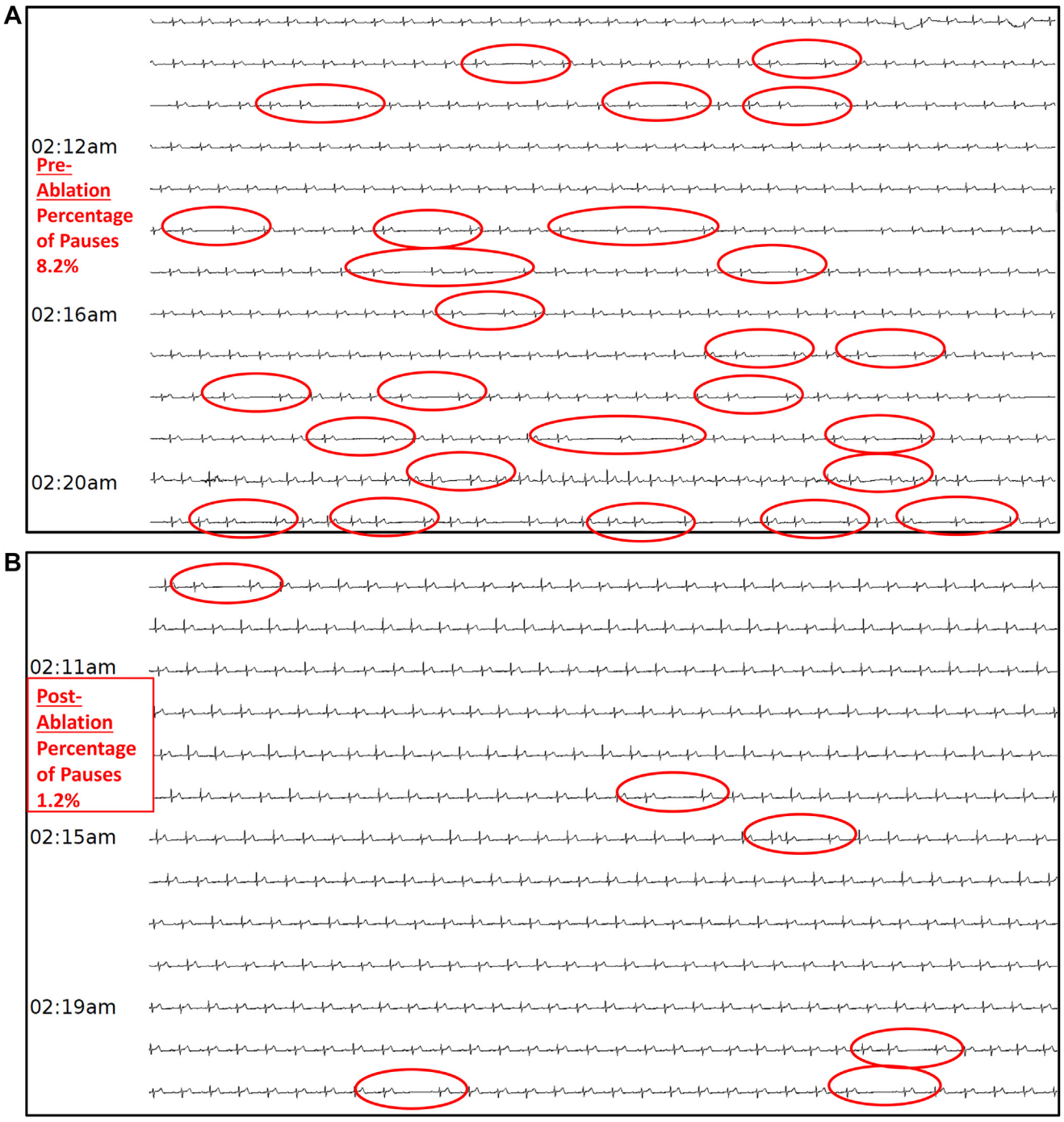

Figure 2 Eight-minute strips from preablation (top panel) and postablation (bottom panel) 14-day electrocardiogram monitoring, during nighttime, showing the frequency of pauses. Both strips show sinus rhythm with Mobitz type I (Wenckebach) dropped beats. The number of pauses is greatly reduced in the post-ablation strips.

reduction in Mobitz type I episodes; however, the first-degree AV block (prolonged PR interval) persisted. AF was not present 6 months after the procedure, based on 14-day monitoring and monitoring using the patient's own devices (an ECG patch and a watch). Although no significant vagal response was demonstrated during the cryoablation procedure, the drastic reduction in Mobitz type I episodes postablation suggested that vagal tone was affected owing to GP ablation.

ECG monitoring results

Table 1 shows a summary report of 4 preablation and 1 postablation 14-day periods of ECG monitoring. The AF burden was stable during the 2 years preceding the ablation, averaging 35%, with the longest AF episode lasting 10 hours and 34 minutes. No AF episodes were recorded following ablation during a 14-day monitoring period performed 3 months after ablation. An average of 117 pauses (>3 seconds) were reported in the 4 preablation monitoring

periods vs two postablation. The longest preablation pause, 7.7 seconds, was recorded in the last preablation monitoring period during the sinus-to-AF conversion (Figure 1). No AF episodes or long pauses (>3 seconds) were found using the patient's own monitoring device in the subsequent 6 months, indicating that the patient has been free of AF and long pauses (>3 seconds) for 9 months. Table 1 also shows significant improvement in the minimum and average heart rates during sinus, 36 and 59 bpm in the preablation vs 49 and 67 bpm in the postablation periods, respectively.

Figure 2 shows a sample of preablation and postablation ECG strips, each with a 10-minute recording of sinus rhythm during nighttime (02:10–02:20). All pauses, marked in red circles, were short and appeared to be the result of skipping 1 beat. Close examination of the waveform using magnification, shown in Figure 3, reveals progressively prolonged PR intervals, indicating that most pauses were Mobitz type I, with some nonconducted premature atrial contractions. The incidence of pauses was calculated by manual examination of ECG strip samples, since the I-Rhythm software only reports long pauses (>3 seconds). The incidence of short pauses during sleep hours declined from 8.2% in the preablation period to 1.2% in the postablation period. No long or short pauses were found during waking hours.

The data in Table 1 and Figure 2 denote the improvement in SA and AV node function because of PVI + GP ablation.

Discussion

AF guidelines recommend rhythm control in symptomatic patients, but not asymptomatic patients even with long pauses or Mobitz type 1 AV block.[7] However, 2 recent studies show that early rhythm control, including ablation, resulted in outcomes superior to asymptomatic patients not treated by rhythm control. There was a reduction in the composite of cardiovascular death, stroke, or hospitalization for heart failure or acute coronary syndrome in asymptomatic patients with AF.[8,9]

Furthermore, in this patient, ablation resulted in no AF being recorded 6 months postablation, with no long pauses and much reduced AV block episodes. It is likely that the PAF in this patient would have progressed to persistent AF and further remodeling of SA and AV nodes, possibly leading to worse bradycardia and greater difficulty in achieving successful ablation. Anticoagulation does reduce the risk of stroke, but there remains a significant residual risk in AF patients.

In addition to eliminating AF, there are findings that PVI ablation can also improve AV node function.[10] The latter is attributed in part to the use of the cryoballoon (especially with a 28 mm diameter) that also ablates the GP located near the pulmonary veins as they enter the left atrium, converting the procedure into a PVI + GP ablation. GP ablation has been shown to improve the outcomes of patients with PAF. Its effect on AVND is still unclear but is supported by studies of simulated AF in pigs, rabbits, and dogs by rapid atrial pacing, where it was shown to induce reversible SAND and AVND.[11,12] A single human case report showed that SA and AV node function improved following PVI ablation.[13]

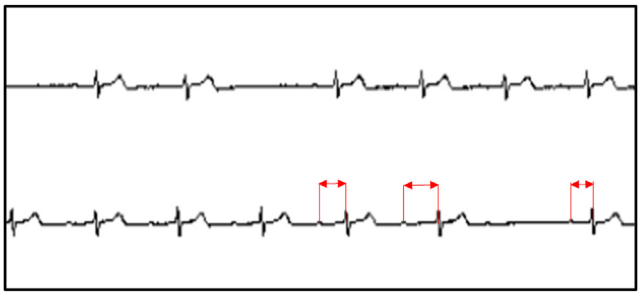

Figure 3 Magnification taken from the preablation electrocardiogram in Figure 2. The red arrows illustrate the progressive prolongation of the PR intervals prior to the dropped beat, indicating Mobitz I (Wenckebach) atrioventricular block.

Interestingly, the patient in the latter report was athletic and, like this patient, also had Mobitz type I episodes (Wenckebach) prior to ablation, but none after ablation.[14] These studies suggest that both SAND and AVND could be a consequence of AF and hence reversed following its abolition. Thus, an added benefit of the ablation procedure in this patient was improved SA and AV node function, presumably because of secondary ablation of the GP and removal of excessive vagal tone, thus possibly aiding him to avoid the need for a pacemaker.

Compared to preablation ECG monitoring, 3 months after ablation, a 14-day ECG monitoring showed that (1) sinus rhythm increased from an average minimum of 27 to 49 postablation; (2) AF with its associated pauses ended; and (3) the proportion of missing beats due to Mobitz type I episodes was drastically reduced, from 8.2% to 1.4% (Figure 2 and Table 1). Although this is a single case, together with the earlier case report,[13,14] it suggests that ablation, rather than permanent pacing, may be a better choice for the initial treatment of asymptomatic, slow AF with SAND and AVND.[15] Table 2 lists the advantages and disadvantages of ablation vs pacing in patients with AF and AVND.

Table 2 Pros and cons of pacing vs ablation in the context of sinoatrial and atrioventricular node dysfunction

Treatment Plan	Risks	Benefits
Continue monitoring	Longer pauses – dizziness, syncope	Avoid invasive procedures
Pacing	AF persists, electrode infection	Eliminates bradycardia and pauses
Cryoablation	General anesthesia, possible damage to PV, atrium, and phrenic nerve	Abolishes AF foci, and ganglionic plexi, with potential recovery of SA and AV node dysfunction

AF = atrial fibrillation; AV = atrioventricular; PV = pulmonary vein; SA = sinoatrial.

Conclusion

Our main conclusion is that in patients with PAF and a slow ventricular response owing to conduction disturbances, PVI + GP ablation should be considered before subjecting the patient to a pacemaker, the reason being that the conduction disturbances may be due to the AF and/or excessive vagal tone, and hence potentially reversible. PVI + GP ablation can not only eliminate the AF, but also reverse both SAND and AVND, and therefore avoid the need for pacing. Indeed, in this case study, in addition to complete elimination of AF, the ablation resulted in significant improvement of sinus bradycardia and reduction in Mobitz type I episodes, and abolishment of long pauses, which were the main reason for intervention. A larger study is needed to confirm the findings and conclusions of this case report.

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