

# Is Dynamic Atrial Overdrive Pacing Antiarrhythmic or Proarrhythmic: A Case Report

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**CHAN ET AL.: Is Dynamic Atrial Overdrive Pacing Antiarrhythmic or Proarrhythmic: A Case Report.** *Dynamic atrial overdrive (DAO) pacing algorithm is designed for prevention of atrial arrhythmias, specifically atrial fibrillation (AF). We describe a patient who underwent implantation of a dual chamber pacemaker with DAO function, for sinus node dysfunction, paroxysmal AF and supraventricular tachycardia. The patient developed persistent high rate pacing alternating with a long RP tachycardia, which was maintained by the DAO pacing algorithm. Sinus rhythm resumed on turning off the DAO pacing. (J HK Coll Cardiol 2002;10:198-202)*

*Dynamic atrial overdrive, proarrhythmia*

## 摘要

動態心房超速起搏（DAO）技術用於房性心律失常，尤其是心房纖顫（AF）的治療。1例患者因竇房結功能失常，陣發性心房纖顫和室上性心動過速行帶有DAO功能的雙腔起搏器置入術。患者出現由DAO起搏機制所致的具有長RP特徵的持續性高頻率起搏心律。竇性節律的恢復終止了DAO起搏。

關鍵詞：動態心房超速起搏 致心律失常

## Introduction

Dynamic atrial overdrive (DAO) is a recently described pacing algorithm for prevention of atrial arrhythmias, specifically atrial fibrillation (AF).<sup>1-3</sup> Stabile<sup>2</sup> found that DAO pacing markedly reduced AF recurrences in a group of 47 patients who had both paroxysmal AF and indications for permanent cardiac pacing. DAO pacing algorithm is designed to maintain continuous atrial pacing. This is accomplished by continual monitoring of the atrial rate and promptly

increasing the pacing rate when intrinsic rhythm emerges. The pacing rate is reduced periodically to search for atrial activity and inappropriately rapid pacing is avoided. Possible mechanisms of its effectiveness include prevention of bradycardia, reduction of intraatrial conduction times and reduction of intraatrial dispersion of refractoriness.<sup>4</sup>

DAO pacing is therefore supposed to be antiarrhythmic. A case of supraventricular tachycardia (SVT) maintained by DAO pacing is reported here. To the best of the author's knowledge, this is the first case report describing a possible proarrhythmic effect of DAO pacing.

## Case Report

A 90-year-old woman was referred to our unit for consideration of permanent cardiac pacing. She has history of hypertension and had one episode of syncope

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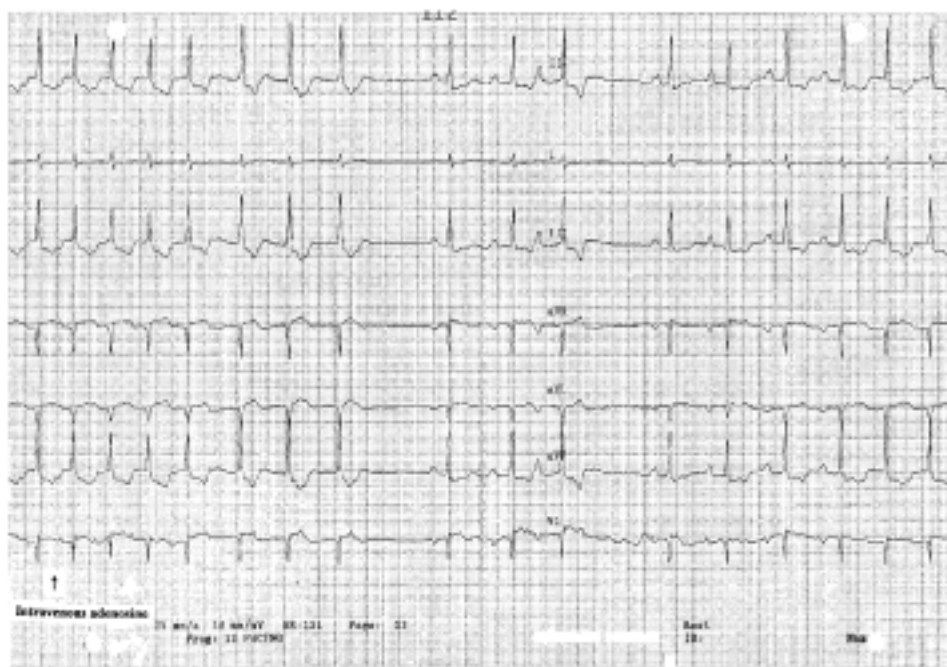
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6 years ago. She also complained of on and off fast palpitation and dizziness. 24 hours Holter monitoring revealed evidence of sinus node dysfunction with pauses of 2 seconds and frequent episodes of supraventricular tachycardia and atrial fibrillation. After obtaining consent from the patient, permanent pacemaker implantation was arranged.

A dual chamber pacemaker with DAO pacing algorithm was chosen. SVT occurred during the procedure both spontaneously and during pacing leads manipulation. It was a long RP tachycardia with rate of 136/min (Figure 1). The P waves were negative in inferior leads. The arrhythmia could only be terminated transiently with intravenous adenosine (Figure 1), atrial or ventricular overdrive pacing. The patient was haemodynamically stable during SVT and the procedure was successful with atrial and ventricular leads placed at right atrial appendage and right ventricular apex respectively. Echocardiogram performed after the procedure revealed satisfactory left ventricular systolic

function. In view of the advanced age, electrophysiology study and radiofrequency ablation of the arrhythmia is not preferred. Verapamil 80 mg thrice daily was started for prevention of SVT. DAO pacing was turned on for paroxysmal AF. The maximum pacing rate was set at 150/min and the search interval was set at 8 cycles. This setting will allow the V-A interval to be lengthened by 8 ms (DAO rate recovery for all rates) when there are 8 consecutive atrial paced beats. This new V-A interval is used until either an intrinsic atrial sensed event occurs and the algorithm shortens the V-A interval by 8 ms (overdrive rate for all rates), or the end of the next search interval of 8 cycles and the V-A interval is again increased by 8 ms.

However, the patient developed persistent high rate sequential atrioventricular pacing 120-130/min after pacemaker implantation. A recurring pattern of sequential atrioventricular pacing followed by several beats of long RP tachycardia and then sequential atrioventricular pacing again was observed (Figure 2).



**Figure 1.** Long RP tachycardia during pacemaker implantation. Negative P waves are well seen in inferior leads. The tachycardia was terminated by intravenous adenosine and recurred spontaneously. There is prolongation of tachycardia cycle length with increasing PR interval just before termination. The tachycardia ends with a P wave. Atrial tachycardia is unlikely with these features.

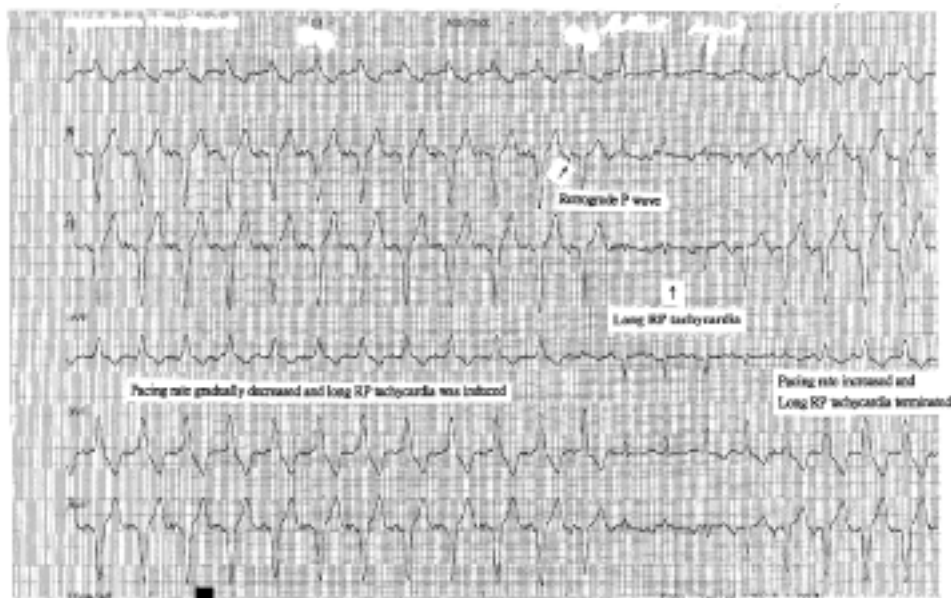
Intravenous adenosine or verapamil failed to terminate this recurring pattern. Verapamil was then stopped and Amiodarone was given. An intravenous loading dose of 200 mg was given, followed by maintenance dose of 600 mg per day for two days and 720 mg per day for another two days. However, same pattern of arrhythmia persisted. On reviewing the recurring and alternating pattern of high rate pacing and long RP tachycardia, the following mechanism was postulated. As shown in Figure 2, the unusual behaviour of DAO mechanism that allows high rate sequential atrioventricular pacing, in this case of rate around 110/min, served to induce the long RP tachycardia. The rate of the tachycardia induced was around 125/min. With the sensed atrial activity during SVT, the V-A interval was gradually shortened according to the DAO pacing algorithm. Sequential atrioventricular pacing at a rate faster than the SVT was then resumed and the SVT was terminated. The V-A interval was then gradually lengthened according to the DAO pacing algorithm and SVT was then induced with a slower pacing rate. This pattern was actually maintained by the DAO pacing algorithm

and the easily inducible SVT.

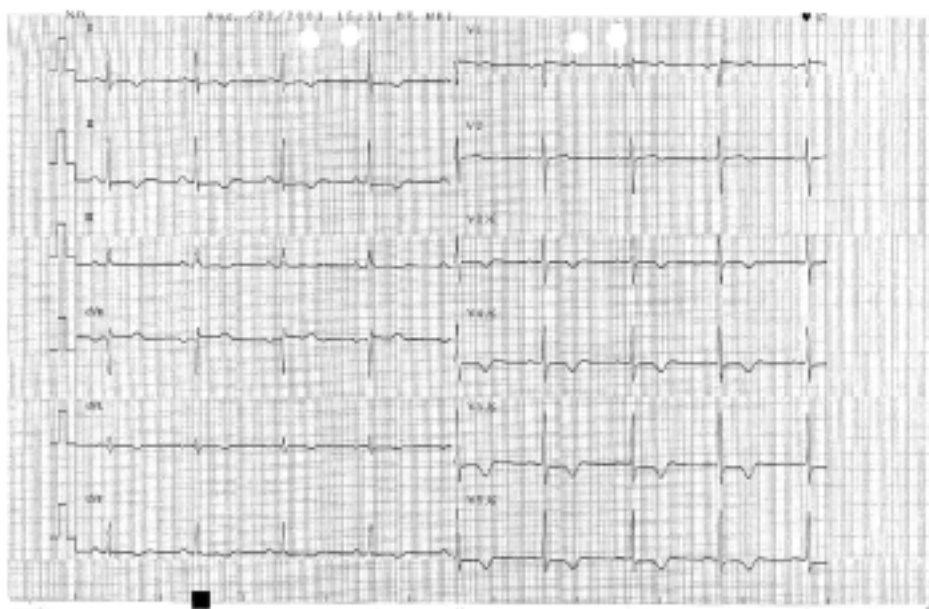
The DAO pacing function was turned off. The arrhythmia subsided immediately and sinus rhythm was resumed (Figure 3). Amiodarone 200 mg once per day was continued for prevention of both paroxysmal AF and SVT. The patient has been followed up for seven months and there has been no clinical recurrence of SVT or AF. 24 hour Holter monitoring did not reveal AF, SVT or persistent high rate pacing.

## Discussion

This patient has a long RP tachycardia. Differential diagnoses include atrial tachycardia, permanent form of junctional reciprocating tachycardia (PJRT) and atypical atrioventricular nodal reentrant tachycardia (AVNRT). The SVT was terminated transiently with intravenous adenosine and the cycle length also varied with the PR interval just before termination (Figure 1). The SVT ended with a P wave. Atrial tachycardia is unlikely with these features. And



**Figure 2.** Incessant high rate sequential atrioventricular pacing alternating with long RP tachycardia. Pacing rate was increased gradually by the dynamic atrial overdrive (DAO) pacing algorithm in response to the long RP tachycardia. The tachycardia was then terminated and high rate sequential atrioventricular pacing remained. The DAO pacing algorithm allows the pacing rate to decrease gradually and at the point indicated by the arrow, a retrograde P wave followed by the same long RP tachycardia was induced. This pattern of arrhythmia has been recurring for days since pacemaker implantation.



**Figure 3.** Sinus rhythm immediately resumed after turning off of the dynamic atrial overdrive pacing.

possibilities therefore include PJRT and atypical AVNRT. Because of the advanced age of this patient, electrophysiology study was not performed and the definitive diagnosis cannot be made.

Spontaneous PJRT initiation and induction during electrophysiology study usually occur after only trivial increases in sinus rate or atrial overdrive pacing.<sup>5</sup> The exact mechanism is not known. One likely mechanism is a concealed Wenckebach-type block at the atrial-bypass tract junction. The block relieves any antegrade concealed conduction that may have prevented retrograde conduction up the bypass tract.<sup>6</sup> An orthodromic atrioventricular reentrant tachycardia is then facilitated. In this case, the fact that the SVT, which is a long RP tachycardia, is readily initiated spontaneously or by atrial overdrive pacing above the sinus rate, favours the diagnosis of PJRT. With the active DAO pacing algorithm, the pacing rate is gradually increased until it is faster than the SVT which is then terminated. The same pacing algorithm allows the pacing rate to drop gradually and at some point, the SVT will be induced again. This pattern becomes persistent and is

maintained by the DAO pacing algorithm and the easily inducible SVT. The remote possibility of persistent SVT even during high rate pacing is highly unlikely. It will require some form of "entrainment" during sequential atrioventricular pacing. This is difficult, if not impossible, to achieve. On the other hand, the fact that sinus rhythm immediately resumed after turning off DAO pacing argues against the mechanism of persistent SVT even during high rate pacing. Effect of Amiodarone also cannot explain the immediate response to the turning off of DAO pacing.

Although DAO pacing is designed to be antiarrhythmic in atrial arrhythmias, specifically atrial fibrillation, it can be proarrhythmic. Persistent high rate pacing may result especially in patients with SVT which is easily initiated spontaneously or induced by atrial overdrive pacing just above the sinus rate. Definitive treatment with electrophysiology study and radiofrequency ablation can confirm the diagnosis and eliminate the substrate for arrhythmia. However, when invasive procedure is not preferred as in this patient, the DAO pacing algorithm may have to be turned off.

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