ECRONICON OPEN ACCESS

EC CARDIOLOGY
Review Article

Finding the "Gold Spot" in RV Pacing: A Review Article

Hakim Irfan Showkat[1]*, Sadaf Anwar[2] and Rekha Mishra[3]

[1]*Consultant Interventional Cardiologist, National Heart Institute, Delhi, India*

[2]*Associate Consultant Cardiology, Fortis Escorts, Faridabad, Haryana, India*

[3]*Consultant Non Invasive Cardiology, National Heart Institute, India*

***Corresponding Author:** Hakim Irfan Showkat, Department of Cardiology, National Heart Institute, Community Centre, New Delhi, India.

Received: October 05, 2018; **Published:** November 26, 2018

Abstract

As we know that transvenous pacing has been an advancement in the management of patients with bradycardias and the most basic level ensures rate that will support to maintain the cardiac output. However as we know from a long time now that pacing right ventricle (RV) apex for a long time may lead to left ventricle (LV) dysfunction, atrial fibrillation, heart failure, and it may lead to an increased mortality as reported. So many successful pacing algorithms and designs have been developed and designed so as to minimize unnecessary ventricular pacing but it is not always possible to avoid it in a proportion of pacemaker-dependent patients. As there is an undoubted evidence that RV apical pacing has deleterious effects but there has been an emerging evidence that pacing from the RV septum is associated with a shorter duration of activation, improved hemodynamics, and less LV remodeling. In addition concerns about the stability and longevity of steroid-eluting active fixation leads have proven to be unfounded. All the implanters at present have adopted RV septal pacing so that it can minimize the likely harm to their patients although it is not very well proven that other pacing site may give much benefit. This review will talk about the alternate site pacing and its consequences.

Keywords: *Right Ventricle (RV); Left Ventricle (LV)*

Introduction

Right ventricle has been an established practice for decades, but the optimal site of pacing has stayed a controversy to preserve hemodynamic function. Right ventricular (RV) apical pacing has been found to have a negative impact on synchrony of left ventricular contraction. However septal pacing of RV may have an advantage with less chances of dyssynchrony and overall reduced negative impact on the left ventricular (LV) contraction and function. As per literature, the results of many large randomized studies which compared apical and septal pacing were not found to have uniform results. And overall results have been seen to be affected by so many limitations like improper implantation of the lead in the septum, with so many leads apparently being septal, were in fact, implanted off-septum.

For such a long time now, a good number of studies have suggested that RV apical pacing (RVAP) has a potential to induce or worsen left ventricle (LV) contraction with dyssynchrony, LV longitudinal shortening and twist, atrial fibrillation, and heart failure which may cause more morbidity over time [2,3]. All these pathophysiological reasons have been attributed to the violation of several electrophysiological properties of the myocardium and so a reason for myocardial dysfunction [4]. The conduction in the myocardium as we all know is slower at least four times than that in the nervous Purkinje system. The conduction process over the muscle fibers is about two times faster than the perpendicular activation [5]. But as we know the conduction characteristics between the endocardial and epicardial layers are different [6,7]. In the setting of RVAP, the activation front changes and it becomes ellipsoidal, and we are able to see the slowed conduction, particularly in the intermediate and epicardial layers [1,4]. All these have been the reasons that we have been looking for alternative pacing sites which requires a more synchronous ventricular activation pattern and all these over time have been explored [1,4].

The described changes in LV function as mentioned above have generated a search for selective non-apical RV alternative pacing sites so as to achieve a less eccentric and more physiologic pattern of ventricular activation which will be more physiological and with less morbidity overtime [8-11]. As mentioned till date, the other sites for RV pacing which have been explored like the His bundle and parahisian tissues [12,13], the mid-septum [14], the low interventricular septum or RV inflow tract [15,16], the right ventricular outflow tract (RVOT) [17,18] and in particular, the RVOT septum [19]. But out of all these sites, the widely explored of these selective alternative sites has been the RVOT and there has been an increasing focus on the septal aspect as well.

Consequently most studies and in particular the very earlier studies had a potential flaw that the leads which were likely positioned in the mid-RV or RVOT, but not necessarily septal. In a report of RVOT pacing where a simple curved stylet was used and most probably it was similar to the tool which had been used in most of the studies and in this it was seen that only 61% of the leads which were used were shown to be actually on the septum using the LAO (Left anterior oblique) fluoroscopic projection with the remainder on the anterior and free walls [19]. So it always remained a query that why is it important to distinguish septal positioning from other RV sites? When a review of the work of Durrer., *et al.* was done [20], it was found that the septal regions of the LV were the first zones of the ventricle to depolarize and rightly so and it suggested that if we initiate pacing from very close to the areas on the right side of the septum, it will achieve as normal a contraction pattern as is possible. On the other side, the RV free wall will be the last zone which will get depolarized. Whenever it was tried to prove the physiologic and the hemodynamic benefits of septal pacing, it looked to be very illogical to have the RVOT pacing with a mix of both septal and free wall pacing. Thus here the likely beneficial effects of septal pacing are likely to be negated when we do free wall pacing and thus it won't be a surprising result that we see no consistent physiologic benefit of RVOT pacing over RV apical pacing.

Zhang., *et al.* had a comparative study with RVOT pacing vs RVAP in elderly patients with normal LVEF [21]. Their results showed deterioration in the LVEF in patients with RVAP in contrast with those who had RVOT pacing, suggesting that RVOT pacing is better than RVAP in preventing cardiac dysfunction. However a study by Gong., *et al.* [22] found although RVOT pacing caused more synchronous LV contraction than RVAP, but no benefit over RVAP was shown regarding the prevention of cardiac remodeling and preservation of LV systolic function after 12 months of pacing in patients with normal cardiac function. It was shown that RVOT pacing also produced a wide QRS complex with a median QRS duration of 161 ms, a value that was very different and surprising from that in other studies concerning QRSd produced by RVOT septal pacing. So the precise pacing site might be different from others. And such a prolonged QRS duration by RVOT septal pacing may increase heart failure risk similar to long-term RVAP [23].

A latest well organized PROTECT PACE study, showed that pacing from either RV Apex or RV hiss site (RVHS) may result in a small but statistically significant reduction in overall LV function over a 2-year period, but RVHS has not conferred any much of a protective (or detrimental) effect on LV systolic function over RVA pacing. Thus, as of now there is no current indication to change the standard pacing site practice particularly in regard to RV lead placement, as it remains a safe and a very effective treatment for almost all high-degree AV blocks [24].

Study/ reference	Year	No. pts.	Alternate pacing site	Study type	Physiologic investigation	EF	Length study	Result
AF studies								
Victor., et al.	1999	16	RVOT	Some ablation 4M wash-in period	NYHA. 0_2 uptake, exercise time, EF radionuclide	Mixed	Cross-over 3M	**0**
Mera., *et al.*	1999	12	RVOT septal	All ablation No wash-in period	EF radionuclide Fractional shortening	Mixed	Cross-over 2M	+
Stambler., et al.	2002	80	RVOT	Some ablation 3M wash-in period	EF chocardiograph, quality of life, 6M Hall Walk	LV < 40%	Cross-over 3M	**0**
Bourke., *et al.*	2002	20	RVOT	All ablation 6W wash-in period	EF radionuclide	Mixed	Random-ized 4M	0
Victor., *et* al.	2005	28	RV septum	All ablation 4M wash-in period	EF radionuclide	Mixed	Cross-over 3M	**0**
Muto., et *al.*	2007	233	RV mid-septum	Slow AF	EF echocardiograph	LV < 30%	Random-ized 18M	+
Heart Block Studies								
Tse., *et al*	2002	24	RVOT		EF radionuclide	Mixed	Random-ized 18M	+
Vanerio., et al.	2008	150	RVOT	Sane ablation AF	Survival	-	9 to 2694 Days	+
Kypta., *et al.*	2008	98	RV septum		EF echocardiograph, exercise time, natri-uetic peptide	Mixed	Random-ized 18M	**0**
Tse., *et al.*	2009	12	RVOT septal	Upgrade RV apex to RVOT septal also RV apex control	EF radionuclide. 6M Hall Wak	Mixed	18M	
Flevari., *et al.*	2009	31	Low mid-septum		EF echocardiograph, dyssynchrony	Mixed	Random-ized 12M	+

Table 1: *Long-term studies comparing pacing from the right ventricle apex and right ventricle alternate sites.*

AF: Atrial fibrillation: No. Pts: Number of Patients: M : Months: NYNA: New York Heart Association Score; EF: Ejection Fraction.

Conclusion

All the attempts to shift from traditional RV apical pacing to RV septal pacing will require a reluctant change in mindset for many practitioners and beginners, many of whom ironically espouse the merits of avoiding unnecessary ventricular pacing and also practice cardiac resynchronization therapy. The landmarks from anatomy and also the electrocardiographic features seen in RV septal pacing have now

been very well described and easily recognized. Now so many simple tools have been made readily available and are very reliable. In spite of all this, the issue is still controversial and will remain so for time being but more and more evidence is turning in favor of alternative pacing site in RV which is more physiological and may preserve LV function.

Bibliography

1. Hillock RJ and Mond HG. "Pacing the right ventricular outflow tract septum: time to embrace the future". *Europace* 14.1 (2012): 28-35.

2. Wang W., *et al*. "Effects of right ventricular nonapical pacing on cardiac function: a meta-analysis of randomized controlled trials". *Pacing and Clinical Electrophysiology* 36.8 (2013): 1032-1051.

3. Sweeney MO., *et al*. "Adverse effect of ventricular pacing on heart failure and atrial fibrillation among patients with normal baseline QRS duration in clinical trial of pacemaker therapy for sinus node dysfunction". *Circulation* 107.23 (2003): 2932-2937.

4. DaCosta A., *et al*. "Focus on right ventricular outflow tract septal pacing". *Archives of Cardiovascular Diseases* 106.6-7 (2013): 394-403.

5. Spach MS., *et al*. "The discontinuous nature of propagation in normal canine cardiac muscle. Evidence for recurrent discontinuities of intracellular resistance that affect the membrane currents". *Circulation Research* 48.1 (1981): 39-54.

6. Myerburg RJ., *et al*. "The role of canine superficial ventricular muscle fibers in endocardial impulse distribution". *Circulation Research* 42.1 (1978): 27-35.

7. Frazier DW., *et al*. "Transmural activations and stimulus potentials in three-dimensional anisotropic canine myocardium". *Circulation Research* 63.1 (1988): 135-146.

8. Sweeney MO and Hellkamp A. "Heart failure during cardiac pacing". *Circulation* 113.17 (2006): 2082-2088.

9. Tops LF., *et al*. "The effects of right ventricular apical pacing on ventricular function and dyssynchrony". *Journal of the American College of Cardiology* 54.9 (2009): 764-776.

10. Lieberman R., *et al*. "Selective site pacing: defining and reaching the selected site". *Pacing and Clinical Electrophysiology* 27 (2004): 883-886.

11. Zanon F., *et al*. "A feasible approach for direct His-bindle pacing using a new steerable catheter to facilitate precise lead placement". *Journal of Cardiovascular Electrophysiology* 17.1 (2006): 29-33.

12. Deshmukh P., *et al*. "Permanent direct His-bundle pacing: a novel approach to cardiac pacing in patients with normal His-Purkinje activation". *Circulation* 101.8 (2000): 869-877.

13. Rosso R., *et al*. "Right ventricular septal pacing: a comparative study of outflow tract and mid ventricular sites". *Pacing and Clinical Electrophysiology* 33.10 (2010): 1169-1173.

14. Flevari P., *et al*. "Long-term non outflow septal versus apical right ventricular pacing: relation to left ventricular dyssynchrony". *Pacing and Clinical Electrophysiology* 32.3 (2009): 354-362.

15. Kaye G., *et al*. "Search for the optimal right ventricular pacing site: design and implementation of three randomized multicenter clinical trials". *Pacing and Clinical Electrophysiology* 32.4 (2009): 426-433.

16. Vlay SC. "Right ventricular outflow tract pacing: practical and beneficial. A 9-year experience of 460 consecutive implants". *Pacing and Clinical Electrophysiology* 29.10 (2006): 1055-1062.

17. Stambler BS., *et al*. "Right ventricular outflow versus apical pacing in pacemaker patients with congestive heart failure and atrial fibrillation". *Journal of Cardiovascular Electrophysiology* 14.11 (2003): 1180-1186.

18. Mond HG., *et al*. "The right ventricular outflow tract: the road to septal pacing". *Pacing and Clinical Electrophysiology* 30.4 (2007): 482-491.

19. McGavigan AD., *et al*. "Right ventricular outflow tract pacing: radiographic and electrocardiographic correlates of lead position". *Pacing and Clinical Electrophysiology* 29.10 (2006): 1063-1068.

20. Durrer D., *et al*. "Total excitation of the isolated human heart". *Circulation* 41.6 (1970): 899-912.

21. Zhang H., *et al*. "Comparison of right ventricular apex and right ventricular outflow tract septum pacing in the elderly with normal left ventricular ejection: long-term follow-up". *Kardiologia Polska* 70.11 (2012): 1130-1139.

22. Gong X., *et al*. "Is right ventricular outflow tract pacing superior to right ventricular apex pacing of cardiovascular disease in patients with normal cardiac function?" *Clinical Cardiology* 32.12 (2009): 695-699.

23. Chen S., *et al*. "Paced QRS duration as a predictor for clinical heart failure events during right ventricular apical pacing in patients with idiopathic complete atrioventricular block: results from an observational cohort study (PREDICT-HF)". *European Journal of Heart Failure* 15.3 (2013): 352-359.

24. Gerald C Kaye., *et al*. "Effect of right ventricular pacing lead site on left ventricular function in patients with high-grade atrioventricular block: results of the Protect-Pace study". *European Heart Journal* 36.14 (2015): 856-862.

Volume 5 Issue 12 December 2018