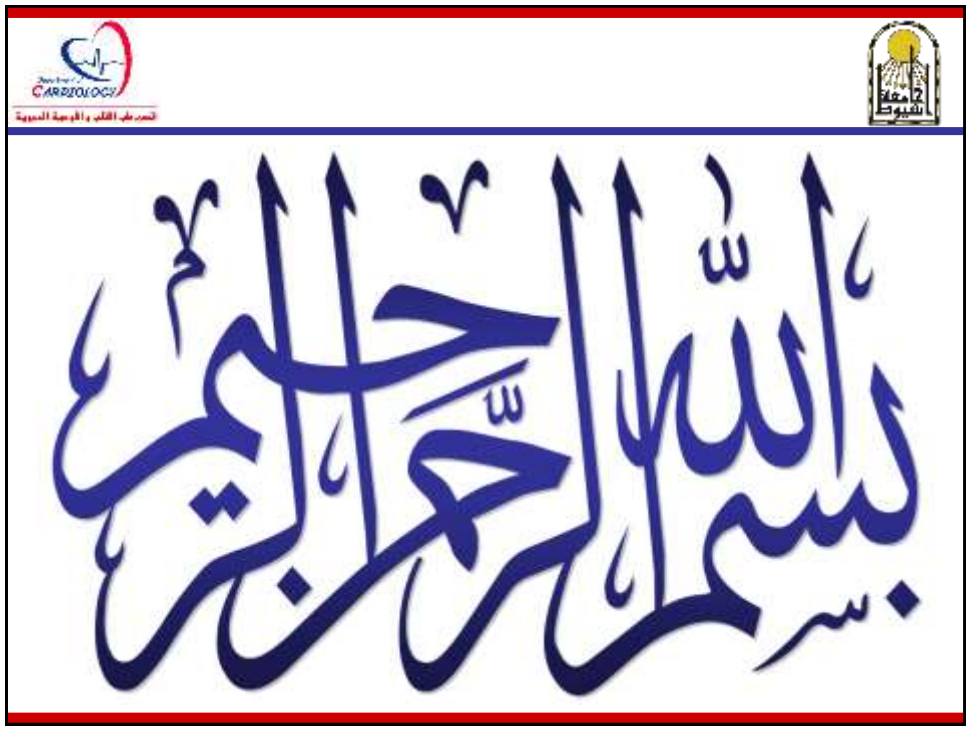


Right Ventricular Septal Pacing in the Clinical Practice

Ahmed Abdel-Galeel, MD

Cardiovascular Medicine Department
Assiut University - EGYPT

Agenda

My agenda will involve:

- Introduction.
- Right ventricular apical pacing.
- Alternative right ventricular pacing sites.
- Right ventricular septal pacing.
- Take home message.

INTRODUCTION

Introduction

- From its first human implantation (October 8th, 1958 by Swedish Surgeon Ake Senning), the right ventricular apical pacing has saved millions of lives.
- The right ventricular apex has been the traditional site of choice for pacer lead placement worldwide over many years.

Introduction

- This site has proven to be stable and safe over long periods of time.
- Era of the concept that right ventricular apical pacing results in ventricular dessynchrony with consequent deterioration of left ventricular systolic function dates back to the middle of the 1990s, (Leclercq et al. 1995)

Introduction

- These concerns has directed the attention towards non-apical right ventricular sites for cardiac pacing.
- These sites included His bundle, para-Hisian region, right ventricular septum and outflow tract area.

Right Ventricular Apical Pacing

Right ventricular apical pacing

The right ventricular apex is a commonly preferred site for placement of right ventricular pacing lead because of:

(1) It is easily accessible; in the direction of right ventricular inlet.

(2) Safe and stable position; due to its dependant position with dense muscular trabeculae.

Right ventricular apical pacing

- However, the short and long-term mechanical consequences of permanent apical pacing were evaluated.
- There is a detrimental acute effect on LV global systolic function with more dyssynchronous LV contraction together with impairment in LV longitudinal shortening, (Delgado et al. 2009).

Right ventricular apical pacing

- The long-term effect was also evaluated among patients with normal LVEF who were prospectively randomized to pacing either from the right ventricular apex or the RVOT septum.
- After more than two years follow up, there was significant deterioration in LVEF, LV and LA volumes, favoring the RVOT septal-paced group (Leong et al., 2010).

Right ventricular apical pacing

- The MOde Selection Trial (MOST) showed that the patients with baseline lower EF, history of MI and a worse NYHA class are more likely to have these adverse events, (Lamas et al., 2002).
- Batista et al. 2013, have shown that even in patients with normal EF, RV apical pacing leads to change in functional class, worsening in walk test, increased B-natriuretic peptide levels at the end of 2 years.

Right ventricular apical pacing

- Interestingly, despite these observations, clinical experience indicates that the majority of pacemaker patients tolerate chronic right ventricular apical pacing reasonably well.
- In the MOST study, only about 10% of patients had heart failure during follow-up.

Right ventricular apical pacing

- Retrospective analysis of the MOST suggests that the risks of HF and AF can be directly linked to right ventricular apical pacing burden (cumulative percent ventricular pacing) regardless of the pacing mode.
- This can be partially managed by manipulation of pacing modes among patients with reliable AV conduction to minimize unnecessary ventricular pacing and preserve normal ventricular conduction.

Right ventricular apical pacing

- However, in patients with high presumed ventricular pacing burden (when permanent conduction defect is present), pacing at alternate ventricular site(s) to attenuate the adverse effects imposed by ventricular dessynchrony should be employed.

Right ventricular apical pacing

- Currently, the absolute indication for RV apical positioning of the ventricular lead in dual chamber pacemaker is hypertrophic obstructive cardiomyopathy.
- RV apical pacing can also be considered appropriate for patients in whom presumed pacing burden is very low (i.e., paroxysmal conduction defect).

Alternate Ventricular Pacing Sites

Alternate Ventricular Pacing Sites

- The alternatives to right ventricular apical pacing are numerous but not well defined.
- They include His-bundle pacing and para-Hisian pacing, medial septum, lower septum, RVOT septal region and, finally, pulmonary infundibulum.

Direct His Bundle Pacing

• Direct His pacing:

• It utilizes the native His-Purkinje conduction system.

• It is supposed to be the most physiological ventricular pacing site for patients with AV nodal or supra-hisian block.

Direct His Bundle Pacing

• It does not induce interventricular or intraventricular asynchrony or trigger the myocardial perfusion disorders described with RVA pacing as it produces ventricular contraction via the specific native conduction system, (Catanzariti et al., 2006).

Direct His Bundle Pacing

- Direct HBP is accomplished with a steerable catheter inserted via the subclavian vein, through which a dedicated bipolar, lumen less, screw in, steroid-eluting, 4 Fr lead is advanced into the area of triangle of Koch and mapping of the triangle is performed until the best near-field His bundle signal is recorded, with the aid of a previously positioned quadripolar catheter at His region.

Direct His Bundle Pacing

- Once the His signal has been recorded by means of the pacing lead, usual fixation of the lead takes place.
- Alternatively, this can be done with conventional active fixation leads.
- The safety and feasibility of HBP with conventional pacing leads have been shown in several studies.

Direct His Bundle Pacing

• Drawbacks of HBP:

• (1) Higher pacing threshold owing to the fibrous structure (less myocardium).

• (2) Instability of the lead due to close proximity of the tricuspid valve and its movements.

Direct His Bundle Pacing

• (3) Lengthy procedure with low success rate.

• (4) In some patients, the conduction defect may extend downwards to involve the His region as well with the lead site itself, so an additional safety lead should be considered at the apex or right outflow tract to prevent asystole.

Para-Hisian Pacing

• Para-hisian pacing:

• It involves simultaneous activation of the His bundle and ventricular septal myocardium.

• PHP is simpler and more reliable, with physiological ventricular activation of the high muscular part of the intraventricular septum, and also early invasion of the His-Purkinje conduction system, very similar to the activation that can be achieved by direct HBP.

Para-Hisian Pacing

• PHP is evidenced by wider paced QRS than spontaneous QRS (but the duration is still at least 50 ms shorter than the QRS obtained with RV apical pacing).

• The paced electrical axis is concordant with that of the spontaneous QRS.

• The pace-ventricular interval is significantly shorter than HV interval of the original rhythm.

Right Ventricular Septal Pacing

- Right ventricular septal pacing:
- It involves a large area of the right ventricle.
- It includes:
- (1) Right ventricular outflow tract septum.
- (2) Mid-septal region.
- (3) Lower septal region.
- (4) Infundibular septal region.

Right Ventricular Septal Pacing

- RVOT septum is the most studied area, given the ease of lead implantation and lead stability in this region.
- The area of the RVOT includes several parts, with the septum behind, RV free wall in front and a part of the anterior wall. This area is surrounded by the pulmonary valve above and the tricuspid valve below.

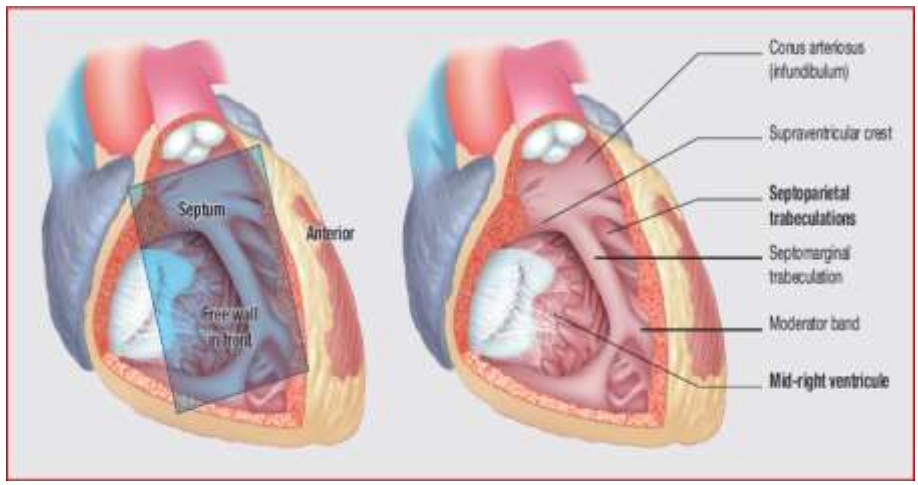
Right Ventricular Septal Pacing

- The septal area of this region should be targeted.
- Being situated high within the septum, it is more favorable to physiological pacing.
- This area is situated just below the region known as ‘crista supraventricularis’ and contains trabeculations, that facilitate the implantation of the lead .

Right Ventricular Septal Pacing

- Though, both mid- and lower septal pacing can be achieved with excellent pacing thresholds, they produce somewhat wider paced QRS complex.
- On the other hand, the infundibular region (conus arteriosus) is too high and thin to be an area suitable for pacing.
- In addition, pacing thresholds are generally increased in this region.

Right Ventricular Septal Pacing



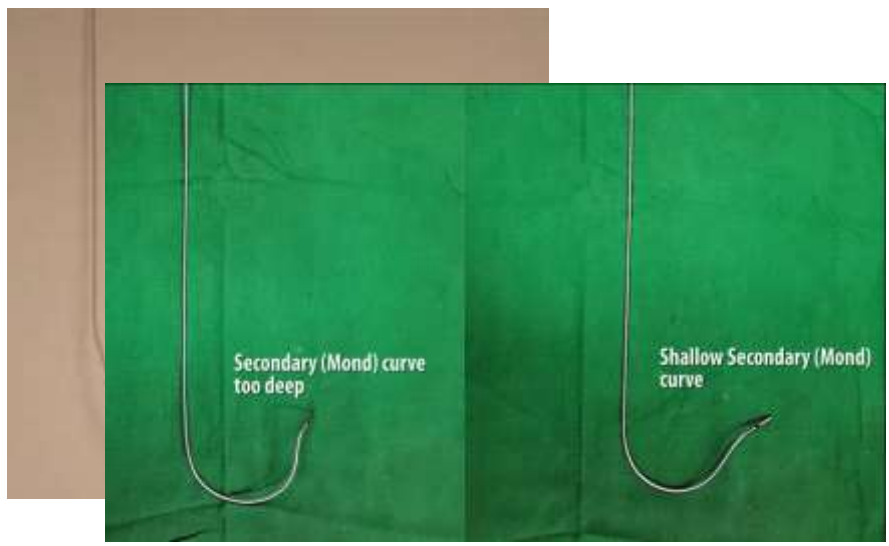
Right Ventricular Septal Pacing

- In practice, to identify the RVOT septal region, this requires three radiologic views:
- (1) AP view to put the catheter between the RVOT and the middle part of the septum.
- (2) RAO view, serving to avoid positioning of the lead at the level of the coronary sinus ostium.

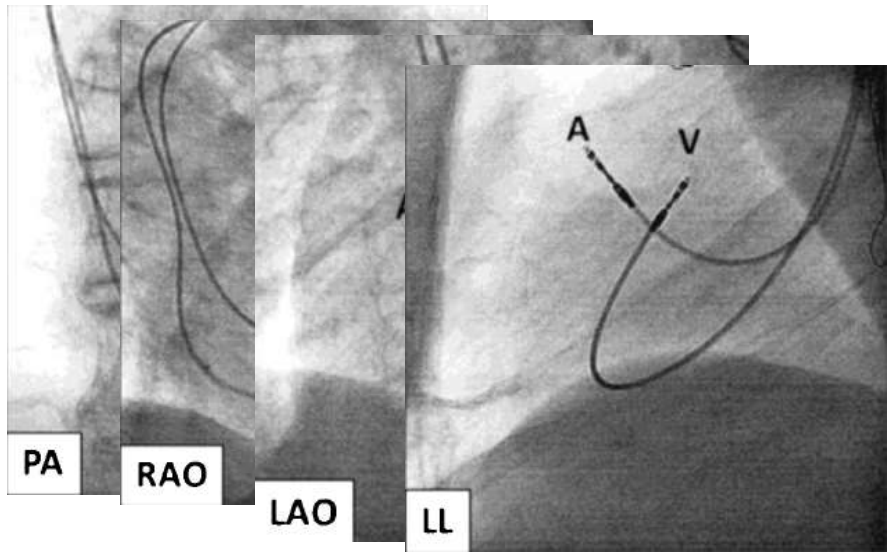
Right Ventricular Septal Pacing

- (3) LAO view to differentiate the septal region from the RV free wall, the septal position being characterized by the posterior orientation of the lead.
- The implantation technique involves a specially shaped stylet (Mond's stylet) for easier implantation of the lead into the interventricular septum.

Right Ventricular Septal Pacing



Right Ventricular Septal Pacing



Right Ventricular Septal Pacing

- The feasibility of this technique was very good, corresponding to 97% of leads implanted in this septal region.
- Failures occurred in the subgroups of patients exhibiting AF, considerable dilatation of the right cavities or high-grade tricuspid insufficiency.
- The risk of displacement was the same as with RV apical pacing.

Apical vs Septal Pacing

- Along the two last decades, there are many studies that compared right ventricular apical with septal pacing regarding different study end-points.
- To sum up, the studies with short term follow up periods showed either no difference or even superiority of apical pacing.
- While those studies with long term follow up gave advantage to RV septal pacing.

Apical vs Septal Pacing

Table 1 Summary of studies comparing right ventricular apical pacing and other sites of right ventricular pacing.

Study	Patients (n)	Pacing site	Evaluation criteria	Follow-up (months)	Results
Victor et al., 1999 [37]	16	RVOT	NYHA; VO_2 max; isotopic EF	3	(−)
Mera et al., 1999 [36]	12	Septal RVOT	Isotopic EF	2	(+)
Stambler et al., 2003 [32]	80	RVOT	EF; quality of life; walking test	3	(−)
Bourke et al., 2002 [41]	20	RVOT	Isotopic EF	4	(−)
Victor et al., 2006 [55]	28	Septal RVOT	Isotopic EF	3	(−)
Muto et al., 2007 [56]	233	Mid-RV septum	Ultrasound EF	18	(+)
Tse et al., 2002 [42]	24	RVOT	Isotopic EF	18	(+)
Vanerio et al., 2008 [57]	150	RVOT	Mortality	18	(−)
Kypta et al., 2008 [58]	12	Septal RVOT	Ultrasound EF	18	(+)
Tse et al., 2009 [59]	12	Septal RVOT	Isotopic EF; walking test	18	(+)
Flevari et al., 2009 [27]	31	Mid-septum	Ultrasound EF	12	(+)

EF: ejection fraction; NYHA: New York Heart Association; RV: right ventricle; RVOT: right ventricular outflow tract; VO_2: oxygen consumption.

Apical vs Septal Pacing

- Only few studies have studied the role of RV lead position in patients with CRT.
- The positioning of the RV catheter at the apex or across the septum did not appear to exhibit different haemodynamic and clinical effects.
- To date, the studies examining the role of septal position were either retrospective or low powered to demonstrate any significant effect.

Apical vs Septal Pacing

Table 2 Summary of studies comparing right ventricular apical pacing and right ventricular outflow tract septal pacing in patient populations requiring cardiac resynchronization therapy.

Study	Patients (n)	Follow-up (months)	Effect	Criteria
Thébault et al., 2012 [46]	346	12.6	NS	Heart failure; mortality; echo data
Rönn et al., 2011 [47]	33 AF	6	NS	Heart failure; echo data
Kristiansen et al., 2012 [45]	85	6	NS	Heart failure; echo data
Khan et al., 2011 [44]	131	6	NS	Heart failure; echo data
All four studies	595	8	NS	Heart failure; echo data

AF: atrial fibrillation; NS: not significant.

Apical vs Septal Pacing

- Concerning defibrillation leads, given their greater rigidity, it was supposed that the risk of perforation would be less if septal pacing was conducted without affecting the pacing and defibrillation thresholds.
- There is only large randomized study designed to evaluate the feasibility and performance of both lead positions.

Apical vs Septal Pacing

- It reported the non-inferiority of the performance of ICD leads implanted in the right mid-septum versus the apex position.
- This is regarding visibility, adverse effects, inappropriate shocks and all cause mortality, (Mabo et al., 2012).

Take Home Message

Take Home Message

- Long-term adverse electromechanical and hemodynamics of RV apical pacing is a proven fact.
- Direct HBP or PHP is supposed to be the most physiological mode of pacing, however, it is clinically difficult and time consuming.

Take Home Message

- RV septal pacing could be appropriate especially in ischaemic patients and those with impaired LV systolic function.
- RVOT septal pacing has not yet been proven to provide benefits in large scale randomized studies but indirect data favor its use compared with apical pacing.

Thank you.. for your attention