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Original Research

Assessment of the effect of different epicardial pacing sites on cardiac output

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ABSTRACT:

Background: Temporary epicardial wire implantation is a routine procedure after open heart surgery. Usually, the epicardial wire is placed in the right ventricle. The present study was conducted to assess the effect of different epicardial pacing sites on cardiac output. **Materials & Methods:** 48 patients who underwent coronary artery bypass grafting of both genders were enrolled. Each patient paced temporarily from 4 sites mentioned in surgical intervention and cardiac output was measured. Epicardial wire was implanted at 4 locations: 1-RV near apex (usual site); 2-LV near apex; 3-LV upper lateral; 4-LV upper septal anterior Medtronic external single chamber generator was used. Cardiac output was measures using NICO with Fick's method from respiratory O2 and CO2. **Results:** Out of 48 patients, males were 30 and females were 18. The mean cardiac output (liter/ minute) at patient's sinus rhythm was 5.92, at RV apex was 4.38, at LV apex was 5.10, at LV lateral wall was 5.42 and at LV high septum was 4.95. The difference was significant ($P< 0.05$). A significant difference was observed on comparing cardiac outputs from different epicardial pacing sites ($P< 0.05$). **Conclusion:** Pacing from left ventricular lateral wall pumps blood most efficiently than other sites of LV and RV wall.

Key words: Cardiac arrest, epicardial wire implantation, ventricular lateral wall

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INTRODUCTION

Effective myocardial contractionrequires not only shortening of contractile myocardial elements but also the synchronization of contraction across elements.[1] Myocardial contractiondyssynchrony can occur from structural changes to the His-Purkinje system, functional changes in regional myocardialcontractility, or both. Alterations in the His-Purkinjesystem include left bundle-branch block (LBBB) or otherintraventricular conduction defects, manifested as nonspecificwidening of the QRS.[2]Cardiac resynchronization therapy (CRT) is

used to minimize left ventricular (LV) contractile dyssynchrony. In CRT, selective ventricular multisite pacing is used to optimize LV mechanical function. The clinical efficacy of CRT is generally quantified in terms of its effects on LV systolic function and other hemodynamic indexes, such as LV ejection fraction, stroke volume (SV), stroke work (SW), maximum rate of LV pressure increase (dP/dtmax), and aortic pulse pressure.[3]

Temporary epicardial wire implantation is a routine procedure after open heart surgery. Usually, the epicardial wire is placed in the right ventricle (RV).[4] RV pacing induces asynchronous electrical activation of the left ventricle (LV) which may have deleterious effects on cardiac function. However, epicardial wire can be placed in any epicardial position during open heart surgery.[5]The present study was conducted to assess the effect of different epicardial pacing sites on cardiac output.

MATERIALS & METHODS

The present study comprised of 48 patients who underwent coronary artery bypass grafting of both genders. The consent was obtained from all enrolled patients.

Data such as name, age, gender etc. was recorded.

Allpatients were in sinus rhythm. Each patient pacedtemporarily from 4 sites mentioned in surgical interventionand cardiac output wasmeasured.Epicardial wire was implanted at 4 locations: 1-RV near apex (usual site); 2-LV near apex; 3-LV upper lateral; 4-LV upper septal anterior Medtronic external single chamber generator was used. Pacingwas performed 10 beat/minute greater than patientheart rate for 1 minute.Ventricular capture during pacingwas confirmed by QRS morphology. Cardiac output was measures using NICO with Fick's methodfrom respiratory O2 and CO2. Data thus obtained were subjected to statistical analysis. P value < 0.05 was considered significant.

RESULTS

Table I Distribution of patients

Total- 48		
Gender	**Males**	**Females**
Number	30	18

Table I shows that out of 48 patients, males were 30 and females were 18.

Table II Cardiac output from different epicardial pacing sites

Site of Epicardial Pacing	Cardiac Output (liter/ minute)Mean	SD
Patient's Sinus Rhythm	5.92	0.56
RV apex	4.38	0.62
LV apex	5.10	0.43
LV Lateral Wall	5.42	0.72
LV High Septum	4.95	0.31

Table II, graph I shows that mean cardiac output (liter/ minute) at patient's sinus rhythm was 5.92, at RV apex was 4.38, at LV apex was 5.10, at LV lateral wall was 5.42 and at LV high septum was 4.95. The difference was significant (P< 0.05).

Graph I Cardiac output from different epicardial pacing sites

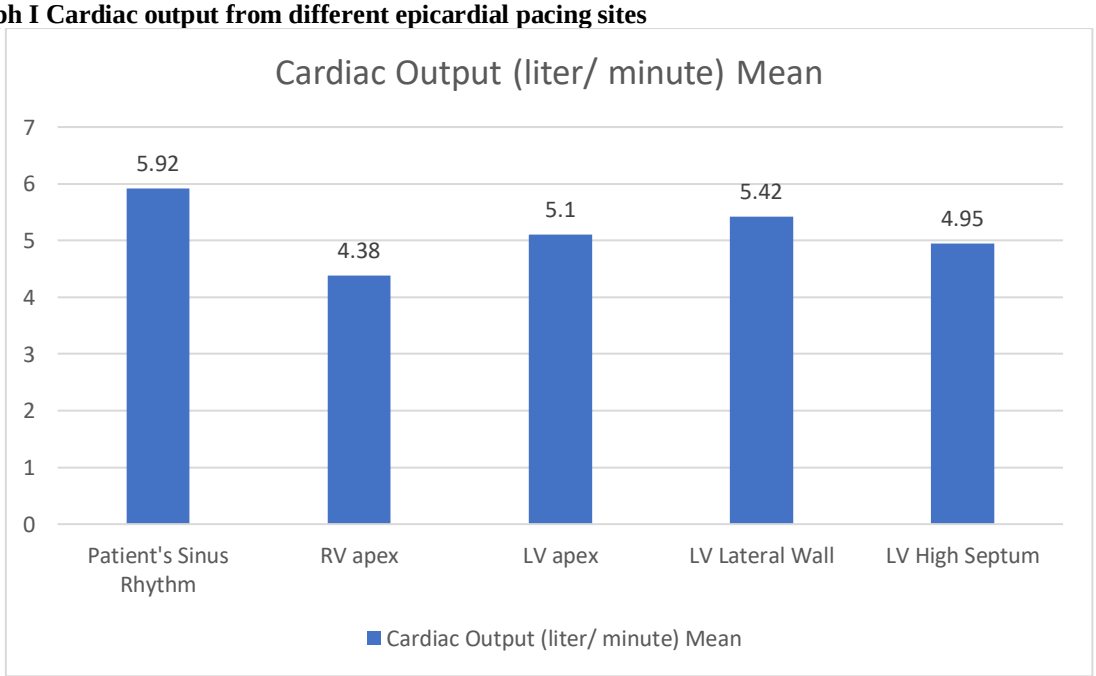

Table III Comparison of cardiac outputs from different epicardial pacing sites

Site of Epicardial Pacing	Cardiac Output (liter/ minute)Mean	SD
Sinus Rhythm vs. RV apex	5.92 vs 4.38	0.05
Sinus Rhythm vs. LV apex	5.92 vs 5.10	0.01
Sinus Rhythm vs. LV lateral	5.92 vs 5.42	0.02
Sinus Rhythm vsLV high septum	5.92 vs. 4.95	0.04
RV Apexvs.LV apex	4.38 vs 5.10	0.01
RV Apexvs.LV Lateral	4.38 vs 5.42	0.01
RV Apexvs.LV Septum	4.38 vs. 4.95	0.05
LV Lateralvs.LV Apex	5.42 vs 5.10	0.02
LV Septumvs.LV Apex	4.95 vs 5.10	0.05
LV Lateralvs.LV Septum	5.42 vs. 4.95	0.03

Table III shows that a significant difference was observed on comparing cardiac outputs from different epicardial pacing sites (P< 0.05).

DISCUSSION

Right apical ventricular pacing with a short AV delay has been proposed as a treatment for patients with congestive heart failure. However, the outcomes to date have been controversial. Consequently, the case of a patient in end-stage heart failure who improved dramatically after initiation of biventricular pacing helped to introduce the concept of multisite pacing. It was hypothesized that multisite ventricular pacing may enhance the synchronous contraction of the dysfunctional left ventricle and thereby improve overall cardiovascular function. Studies to date examining multisite ventricular pacing have been limited but suggestive of a benefit of biventricular pacing despite a high mortality rate.[6,7]The present study was conducted to assess the effect of different epicardial pacing sites on cardiac output.

We observed that out of 48 patients, males were 30 and females were 18. Nikoo et al[8]evaluated the effect of different epicardial pacing sites on cardiac output in patients who underwent cardiac surgery. Patients who underwent coronary artery bypass grafting were selected for this study. Epicardial wire was implanted at 4 locations: 1-RV near apex (usual site); 2-LV near apex; 3-LV upper lateral; 4-LV upper septal anterior. External single chamber generator was used and pacing rate was 10 beat/ minute greater than patient heart rate. Cardiac output (CO) was measured by NICO system which uses Fick's method to calculate cardiac output from respiratory O2 and CO2. In all patients, CO during patients' sinus rhythm was more than RV apical pacing (P< 0.001), LV apical pacing (P=0.016) and LV upper septum pacing (P=0.002). Regarding left versus right side of pacing, LV lateral wall make significantly more output than RV apex (P=0.005). When left sides are compared, LV lateral wall create more output than LV apex (P< 0.001). In comparison, LV apex produces more output than LV upper septum (P< 0.001). Also output from LV lateral wall pacing exceeds LV upper septum (P< 0.001). So, the best LV site for pacing seems to be LV lateral wall.

We found that mean cardiac output (liter/ minute) at patient's sinus rhythm was 5.92, at RV apex was 4.38, at LV apex was 5.10, at LV lateral wallwas 5.42 and at LV high septum was 4.95. Johnson et al[9]assess the effects of left ventricular (LV)pacing siteson radial synchrony and global LVperformance in a canine model of contraction dyssynchrony. Ultra-sound tissue Doppler imaging and hemodynamic (LV pressure-volume) data were collected in seven anesthetized, opened-chest dogs.Right atrial (RA) pacing served as the control, and contractiondyssynchrony was created by simultaneous RA and right ventricular(RV) pacing to induce a left bundle-branch block-like contractionpattern. Cardiac resynchronization therapy (CRT) was implementedby adding simultaneous LV pacing to the RV pacing mode at eitherthe LV apex (CRTa) or free wall (CRTf). A new index of synchronywas developed via pair-wise cross-correlation analysis of tissue Doppler radial strain from six midmyocardial cross-sectional regions, witha value of 15 indicating perfect synchrony. Compared with RApacing, RV pacing significantly decreased radial synchrony and global LV performance (cardiacoutput: 2.00.3 vs. 1.40.1 l/min and stroke work: 13722 vs.6014 mJ,P<0.05). Although both CRTa and CRTf significantlyimproved radial synchrony, only CRTa markedly improved globalfunction (cardiac output: 2.10.2 l/min and stroke work: 11313mJ,P-0.01 vs. RV pacing). Furthermore, CRTa decreased LVend-systolic volume compared with RV pacing without any change inLV end-systolic pressure, indicating an augmented global LV con-tractile state. Thus, LV apical pacing appears to be a superior pacingsite in the context of CRT. The dissociation between changes insynchrony and global LV performance with CRTf suggests thatregional analysis from a single plane may not be sufficient to adequately characterize contraction synchrony

A significant difference was observed on comparing cardiac outputs from different epicardial pacing sites (P< 0.05). Blanc et al[10] assessed the potential value of acute hemodynamic changes associated with pacing the right ventricular apex (RVA) or outflow tract (RVOT) alone, the left ventricle (LV) alone, or biventricular (BIV) pacing of the RVA and LV together.Acute hemodynamic findings were

measured in 27 patients with severe heart failure despite optimal therapy and either first-degree AV block and/or an intraventricular conduction defect. In the 23 patients with a high pulmonary capillary wedge pressure (PCWP) (>15 mm Hg), data were collected after transvenous pacing at different ventricular sites in either the VDD mode (AV delay=100 ms) or the VVI mode in patients with atrial fibrillation (n=6). The mean baseline cardiac index was 1.82 L · min−1 · m−2. Mean±SD baseline systolic blood pressure (SBP) (118.5±15.2 mm Hg), PCWP (26.4±6.6 mm Hg), and V-wave amplitude (39.1±14.6 mm Hg) were similar before and after either RVA or RVOT pacing. In contrast, LV-based pacing (either LV alone or BIV pacing) resulted in higher SBP (P<0.03) and lower PCWP (P<0.01) and V-wave amplitude (P<.001) than either baseline or RV pacing measurements. With LV pacing alone, SBP, PCWP, and V waves were 126.5±15.1, 20.7±5.9, and 25.5±8.1 mm Hg, respectively. The results with LV pacing alone were similar to those obtained with BIV pacing.

CONCLUSION

Authors found that pacing from left ventricular lateral wall pumps blood most efficiently than other sites of LV and RV wall.

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