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Impact of right ventricular lead position on left ventricular functions and early remodeling in permanent single- and dual-chamber pacemakers

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Abstract

Background: Right ventricular (RV) apical pacing can induce both interventricular dyssynchrony and intraventricular dyssynchrony. Mechanical dyssynchrony after long-term RV apical pacing is associated with reduced left ventricular (LV) systolic function and deterioration in functional capacity.

Aim: We aimed to identify the short-term effects of the pacemaker RV lead position on remodeling of LV systolic functions.

Patients and methods: The study included 30 patients who presented with an indication of permanent pacing and who underwent permanent single- or dual-chamber pacemaker insertion: 15 patients with RV apical pacing (RV apex), and 15 patients with non-apical pacing (mid-septal). The two-dimensional (2D) speckle tracking imaging technique was used for quantification of global longitudinal function of the left ventricle and dyssynchrony evaluation before pacemaker implantation and after a 3-month follow-up.

Results: At the 3-month follow-up, post-pacing 2D speckle tracking echocardiography revealed impairment of global longitudinal strain in all patients and intraventricular dyssynchrony was significantly increased in the apical location compared with the non-apical location (radial dyssynchrony: 108.67 ± 11.68 ms vs. 80.53 ± 8.17 ms, $p < 0.001$) with a greater difference (50.53 ± 13.30 ms) in the apical location than in the non-apical location (29.87 ± 6.64 ms, $p < 0.001$).

Conclusion: In the short-term follow-up, 2D speckle tracking echocardiography showed more radial dyssynchrony in the apical location than in the non-apical location of RV lead. The RV septal pacing is a better alternative in terms of less dyssynchrony compared to RV apical pacing. Older age, higher percentage of pacing, and device type are prognostic factors for development of pacemaker-induced cardiomyopathy.

Keywords

Apical pacing · Dyssynchrony · Global longitudinal strain · Pacing-induced cardiomyopathy · Speckle tracking echocardiography

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Introduction

Pacing-induced cardiomyopathy (PICM) is most commonly defined as a drop in left ventricular ejection fraction (LVEF) in the setting of chronic, high-burden right ventricular (RV) pacing [1].

Right ventricular apical pacing can induce both interventricular dyssynchrony

(between the right ventricle [RV] and the left ventricle [LV]), as well as intraventricular dyssynchrony (within the LV; [2]). It has been demonstrated that the presence of ventricular dyssynchrony is associated with an increased risk of cardiac morbidity and mortality in heart failure patients. Also, it has been suggested that the presence of mechanical dyssynchrony after long-term

RV apical pacing is associated with reduced LV systolic function and deterioration in functional capacity [3].

However, few studies have focused on the short-term detrimental effects of pacemaker-related remodeling on LV systolic function in relation to RV lead position [4]. Echocardiographic studies have shown that strain analysis of the myocardium is a very sensitive method for predicting clinical outcomes in various heart diseases; therefore we used two-dimensional (2D) speckle tracking to assess LVEF and intraventricular dyssynchrony [5].

Aim of the work

The aim of our study was to identify the short-term effects of the pacemaker RV lead position on remodeling of LV systolic function.

Patients and methods

Our study was conducted with 30 patients who presented to the Ain Shams University Hospitals from April 2021 to December 2021 with an indication of permanent pacing and who underwent permanent single- or dual-chamber pacemaker insertion.

Oral and written consent, with the explanation of the study and its benefits and its related effects, was obtained from all patients participating in the study. Patients were divided into two groups (15 patients each); the first group received RV apical pacing lead and the second group received non-apical pacing lead (mid-septal position).

Abbreviations

<i>BMI</i>	body mass index
<i>CHB</i>	complete heart block
<i>DM</i>	diabetes mellitus
<i>ECG</i>	electrocardiogram
<i>EF</i>	ejection fraction
<i>GLS</i>	global longitudinal strain
<i>HD</i>	high degree
<i>HS</i>	highly significant
<i>HTN</i>	hypertension
<i>LV</i>	left ventricle
<i>LVEF</i>	left ventricular ejection fraction
<i>NS</i>	non-significant
<i>NYHA</i>	The New York Heart Association functional classification
<i>PICM</i>	pacing-induced cardiomyopathy
<i>RV</i>	right ventricle
<i>S</i>	significant

Inclusion criteria

Patients included in our study were between 18 and 75 years of age. All patients had structurally normal hearts with normal LV functions and a body mass index (BMI) less than 30 kg/m². We included patients who were visiting our outpatient clinic regularly. Patients were enrolled in the study after 3 months of implantation if they had more than 70% pacing dependence on RV leads.

Exclusion criteria

Any patient with previous cardiac surgery or structural heart diseases (e.g., dilated cardiomyopathy, valvular heart disease, congenital cardiac anomalies, and prosthetic valves) was excluded from our study. Also, we excluded patients with documented chronic heart dysrhythmias, slow AF, previous coronary artery disease, a history of chronic obstructive lung disease, pulmonary hypertension, or recent pulmonary embolism, renal impairment, pregnancy, terminal comorbidities such as end-stage malignancy or end-stage renal or liver diseases, postimplantation complications.

Methods

A complete history was taken for each patient including the indication for implantation, presence or absence of structural heart disease, age at implantation, history of early or late postprocedural complications, type of pacemaker implanted, route of implantation, surgical history, heart failure symptoms, and medical history of chronic diseases. A clinical general examination was conducted including weight, height, and BMI in addition to local examination of the pacemaker pocket site.

A baseline 12-lead surface ECG was performed to exclude patients with previous ischemia. Echocardiography was done for assessment of LV function using the Simpson method [6], in addition to obtaining LV global longitudinal strain (GLS) by 2D speckle tracking. In adults, GLS < 16% was considered abnormal, GLS > 18% was normal, and GLS 16%–18% was borderline [7]. Also, quantification of LV intra-

ventricular mechanical dyssynchrony (radial and circumferential dyssynchrony) was done using 2D speckle tracking. Radial and circumferential dyssynchrony was defined as a time difference between the anteroseptal and posterior wall segmental peak strain with a predefined cut-off value of ≥ 130 ms to be considered as significant dyssynchrony [8]. Measurements were made before pacemaker implantation and at follow-up 3 months after implantation (■ Figs. 1 and 2).

Procedure

Implantation of pacemakers was carried out with single- and dual-chamber pacemakers. Fluoroscopy was performed and archived with documentation of the lead location and orientation of the lead tip (AP, RAO 40, LAO 40, and left lateral views). The RV lead was either placed in RV apical position or in a non-apical position (mid-septal position). The choice of RV lead position was according to the operator's preference (■ Fig. 3).

Percentage of pacing assessment

Device assessment sessions in the follow-up clinic took place 3 months after implantation. Ventricular pacing percentage was then reported, and patients with a percentage of pacing of less than 70% after 3 months of pacemaker insertion were excluded from the study [9].

Ethical considerations

All procedures followed were in accordance with the ethical standards of the ethical scientific committee of Ain Shams University and also with the Helsinki Declaration of 1975 (in its most recently amended version).

Statistical analysis

Data were collected, revised, coded, and entered into the Statistical Package for Social Science (IBM Corp. IBM SPSS statistics for Windows, Version 23.0. Armonk, NY, USA: IBM Corp.). Quantitative data with parametric distribution are presented as mean, standard deviations, and ranges while data with non-parametric distribution are presented as median with inter-

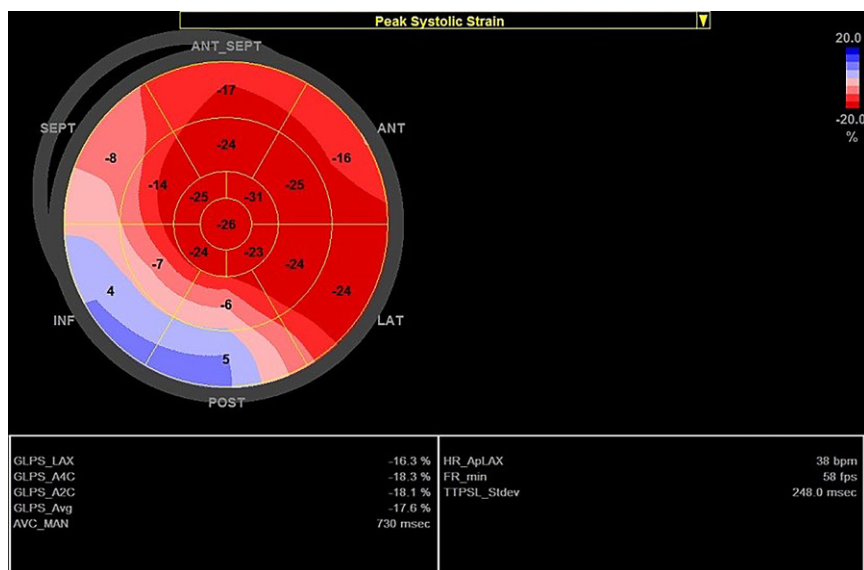


Fig. 1 ▲ Topographic representation of the regional and global longitudinal strain of all 17 segments analyzed (bull's-eye configuration) in candidate no. 18 before pacing

quartile range (IQR). Qualitative variables are presented as numbers and percentages.

The comparison between groups regarding qualitative data was made using the chi-square test and/or Fisher exact test when the expected count in any cell was found to be less than 5.

The comparison between two independent groups with quantitative data and parametric distribution was made with an independent *t* test. The comparison between two paired groups with quantitative data and parametric distribution was made using a paired *t* test.

The confidence interval was set to 95% and the margin of error accepted was set to 5%. Thus, statistical significance was set according to the following criteria:

- $p > 0.05$: nonsignificant (NS)
- $p < 0.05$: significant (S)
- $p < 0.01$: highly significant (HS)

Results

This study was conducted with 30 patients admitted to Ain Shams University Hospitals during the period April–December 2021. There were 12 females (40.0%) and 18 males (60%) with an age range from 49 to 73 years, a mean age of 63.73 ± 7.68 years, and a BMI ranging from 22.2 to 29 kg/m².

Demographic data and characteristics of the study cases

There was no statistically significant difference found between the two groups regarding demographic data including age, gender, and BMI. The two groups were equal in gender distribution with nine males and six females in each group (Table 1).

Clinical data of the study cases

There was no statistically significant difference found between the two groups in terms of their medical history, indication for permanent pacing, implanted device type, and percentage of pacing, which was high in both groups ranging from 80% to 100%. All patients had complete heart block as an indication for pacing. Overall, 11 patients had a dual-chamber pacemaker with septal RV lead position and 10 patients with a dual-chamber pacemaker had apical RV lead position (Table 1).

Echocardiographic data of the study cases

Before vs. after pacemaker implantation: apical pacing group and non-apical pacing group
 Before device implantation, there was no statistically significant difference found between the non-apical pacing group and apical pacing group regarding echocardiographic data. There was no significant difference regarding ejection fraction by Simpson's method, LV GLS by 2D speckle tracking, and radial dyssynchrony by 2D speckle tracking, which was 50.67 ± 6.11 ms in the non-apical pacing group vs. 58.13 ± 13.32 ms in the apical pacing group. Mean EF was $60.07 \pm 6.33\%$ in the non-apical pacing group vs. $58.13 \pm 7.44\%$ in the apical pacing group.

Also, there was no statistically significant difference found between the non-apical pacing group and apical pacing group regarding echocardiographic data after pacemaker implantation except for radial dyssynchrony, which differed significantly between the two groups at $p < 0.001$. Intraventricular dyssynchrony was significantly more widely observed in the apical location as compared to the non-apical location (radial dyssynchrony: 108.67 ± 11.68 ms vs. 80.53 ± 8.17 ms; Table 2).

Before vs. 3 months after pacemaker implantation: non-apical pacing group

Regarding echocardiographic data before pacing and at 3 months after pacemaker implantation among the non-apical pacing group of patients, there was no statistically significant difference found in the EF by Simpson's method. However, GLS and radial dyssynchrony showed a highly statistically significant difference before and after pacemaker implantation among the non-apical pacing group of patients: $p < 0.001$ for the two methods. The GLS changed from $-18.18 \pm 0.83\%$ to $-16.52 \pm 1.21\%$ and radial dyssynchrony changed from 50.67 ± 6.11 ms to 80.53 ± 8.17 ms 3 months after pacemaker implantation in the non-apical pacing group (Table 3).



Fig. 2 ◀ Assessment of left ventricular (LV) radial dyssynchrony and the latest mechanical activated segment by two-dimensional speckle tracking radial strain imaging. The midventricular short-axis view of the left ventricle is divided into six segments, and the time–radial strain curves are displayed. LV dyssynchrony is calculated as the time difference in peak radial strain between the anteroseptal and posterior segments as shown for candidate no. 2 before pacing

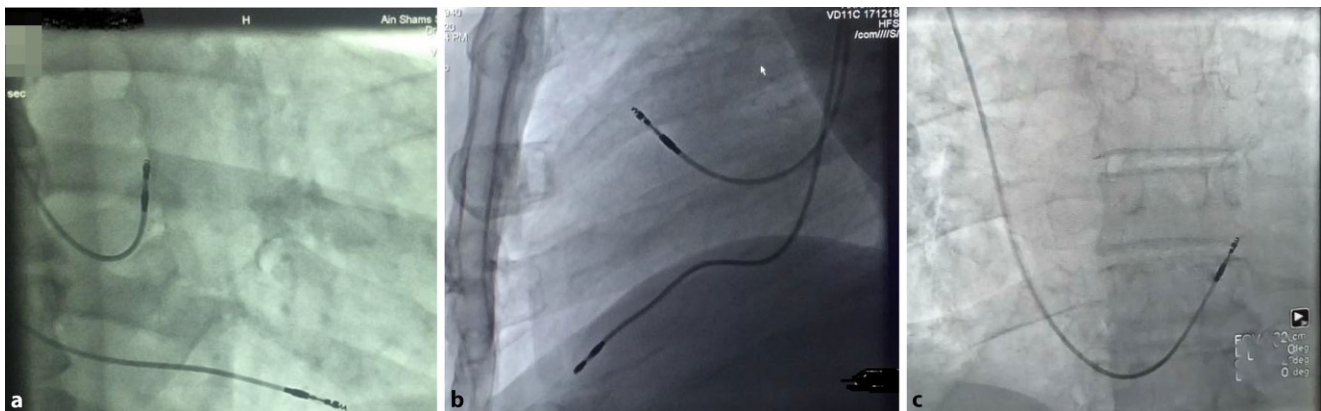


Fig. 3 ▲ Fluoroscopic images of apical lead locations of right ventricular (RV) pacing in anteroposterior view (a), lateral position (b) and septal lead location of RV pacing in anteroposterior view (c)

Before vs. 3 months after pacemaker implantation: apical pacing group

Regarding echocardiographic data before pacing and 3 months after pacemaker implantation among the apical pacing group of patients, there was no statistically significant difference found in the EF by Simpson’s method. However, GLS and radial dyssynchrony showed a highly statistically significant difference before and after implantation among the apical pacing group of patients: $p < 0.001$ for the two methods. The GLS changed from $-17.95 \pm 0.85\%$ to $-16.17 \pm 1.04\%$ and radial dyssynchrony changed from 58.13 ± 13.32 ms to 108.67 ± 11.68 ms 3 months after pacemaker implantation in the apical pacing group (Table 4).

Regarding the difference in radial dyssynchrony pre & post-pacing, there was a statistically highly significant difference between both groups with p -value < 0.001 . Radial dyssynchrony difference was 50.53 ± 13.30 msec in the apical pacing group with more difference compared to the non-apical pacing group with 29.87 ± 6.64 msec difference.

Risk factors associated with the deteriorated GLS

In adults, GLS $< 16\%$ is abnormal, GLS $> 18\%$ is normal, and GLS $16\%–18\%$ is borderline [7]. At the 3-month follow-up by speckle tracking echocardiography, GLS showed more deterioration with ab-

normal result below the value of -16% in 12 patients, i.e., 40.0% of all study patients.

Relation between GLS deterioration and demographic data

There was no statistically significant relationship found between the demographic data and GLS deterioration except for age, which showed a statistically significant relationship. Older patients (68.58 ± 6.52 years) had more deteriorated GLS ($p = 0.003$). Although male gender was predominant in the deteriorated GLS group vs. the non-deteriorated GLS (75% vs. 50%), this did not reach statistical significance (Table 5).

Table 1 Comparison of demographic and clinical data between the apical and non-apical pacing group

		Non-apical pacing group <i>n</i> = 15	Apical pacing group <i>n</i> = 15	Test value	<i>p</i>	Sig.
Age	Mean ± SD	63.80 ± 7.06	63.67 ± 8.50	0.047 ^b	0.963	NS
	Range	52–73	49–73			
Gender	Female	6 (40.0%)	6 (40.0%)	0.000 ^a	1.000	NS
	Male	9 (60.0%)	9 (60.0%)			
Weight (kg)	Mean ± SD	72.13 ± 7.32	69.53 ± 9.34	0.849 ^b	0.403	NS
	Range	62–83	59–86			
Height (m)	Mean ± SD	1.70 ± 0.08	1.68 ± 0.09	0.876 ^b	0.388	NS
	Range	1.57–1.78	1.58–1.82			
BMI (kg/m ²)	Mean ± SD	24.87 ± 1.11	24.67 ± 1.82	0.363 ^b	0.719	NS
	Range	23.2–26.2	22.2–29			
Percentage of pacing	Mean ± SD	91.33 ± 8.34	89.73 ± 9.28	0.497 ^b	0.623	NS
	Range	80–100	80–100			

p > 0.05: non (NS); *p* < 0.05: significant (S); *p* < 0.01: highly significant (HS)
 BMI body mass index
^aChi-square test
^bIndependent *t* test

Table 2 Comparison of data before and after pacemaker implantation between the non-apical pacing group and apical pacing group

			Non-apical pacing group <i>n</i> = 15	Apical pacing group <i>n</i> = 15	Test value ^a	<i>p</i>	Sig.
Before im-plantation	EF (Simpson's method)	Mean ± SD	60.07 ± 6.33	58.13 ± 7.44	0.766	0.450	NS
		Range	51–70	50–75			
	GLS % (SIC)	Mean ± SD	-18.18 ± 0.83	-17.95 ± 0.85	-0.741	0.465	NS
		Range	-19.6--16.5	-19.1--15.7			
	Radial dyssynchrony (msec)	Mean ± SD	50.67 ± 6.11	58.13 ± 13.32	-1.973	0.058	NS
		Range	42–62	42–98			
3 months after im-plantation	EF (Simpson's method)	Mean ± SD	59.67 ± 6.62	57.80 ± 7.54	0.720	0.477	NS
		Range	50–70	50–75			
	GLS %	Mean ± SD	-16.52 ± 1.21	-16.17 ± 1.04	-0.842	0.407	NS
		Range	-18.2--14.3	-17.8--13.7			
	Radial dyssynchrony (msec)	Mean ± SD	80.53 ± 8.17	108.67 ± 11.68	-7.646	0.000	HS
		Range	68–95	82–122			

p > 0.05: nonsignificant (NS); *p* < 0.05: significant (S); *p* < 0.01: highly significant (HS)
 GLS global longitudinal strain
^aIndependent *t* test

Relation between GLS deterioration and clinical data

There was no statistically significant relationship found between the clinical data and GLS deterioration except for device type and percentage of pacing. Eight out of 12 patients with GLS deterioration had a single-chamber pacemaker (66.7% vs. 5.6% in non-deteriorated GLS group; *p* < 0.001). The percentage of pacing was also significantly related to GLS deterioration. Patients with GLS deterioration had a higher percentage of pacing 98.33 ± 3.89% vs. 85.33 ± 6.92 in the

non-deteriorated GLS group (*p* < 0.001; **Table 6**).

Discussion

Pacing-induced cardiomyopathy (PICM) is most commonly defined as a drop in LVEF in the setting of chronic, high-burden RV pacing [1]. It has been suggested that the presence of mechanical dyssynchrony after long-term RV apical pacing is associated with reduced LV systolic function and deterioration in functional capacity [3]. Our study aimed to identify the short-

term effects of the RV lead position on remodeling of LV systolic function.

Our study included 30 patients who presented to the Ain Shams University Hospitals with an indication for permanent pacemaker implantation. All 30 patients underwent permanent pacemaker insertion; 15 patients had apical RV lead position and the rest had septal pacing. All patients were assessed before pacemaker implantation by echocardiography for EF by Simpson's method and by 2D speckle tracking for LV GLS as well as for intraventricular dyssynchrony by radial dyssynchrony measurement. These measures were fol-

Table 3 Comparison of echocardiographic data before vs. 3 months after pacemaker implantation among patients in the non-apical pacing group						
Non-apical pacing group		Before implantation	3 months after implantation	Test value ^a	p	Sig.
		n = 15	n = 15			
EF (Simpson's method)	Mean ± SD	60.07 ± 6.33	59.67 ± 6.62	-2.103	0.054	NS
	Range	51–70	50–70			
GLS %	Mean ± SD	-18.18 ± 0.83	-16.52 ± 1.21	7.624	0.000	HS
	Range	-19.6--16.5	-18.2--14.3			
Radial dyssynchrony (msec)	Mean ± SD	50.67 ± 6.11	80.53 ± 8.17	17.414	0.000	HS
	Range	42–62	68–95			

p > 0.05: nonsignificant (NS); p < 0.05: significant (S); p < 0.01: highly significant (HS)
GLS global longitudinal strain
^a Paired t test

Table 4 Comparison of echocardiographic data before vs. 3 months after pacemaker implantation among patients in the apical pacing group						
Apical pacing group		Before implantation	3 months after implantation	Test value ^a	p	Sig.
		n = 15	n = 15			
EF (Simpson's method)	Mean ± SD	58.13 ± 7.44	57.80 ± 7.54	-2.092	0.055	NS
	Range	50–75	50–75			
GLS %	Mean ± SD	-17.95 ± 0.85	-16.17 ± 1.04	11.485	0.000	HS
	Range	-19.1--15.7	-17.8--13.7			
Radial dyssynchrony (msec)	Mean ± SD	58.13 ± 13.32	108.67 ± 11.68	14.718	0.000	HS
	Range	42–98	82–122			

p > 0.05: nonsignificant (NS); p < 0.05: significant (S); p < 0.01: highly significant (HS)
GLS global longitudinal
^a Paired t test

Table 5 Relation between deteriorated GLS result and demographic data of the patients						
		Non-deteriorated GLS	Deteriorated GLS	Test value	p	Sig.
		n = 18	n = 12			
Age	Mean ± SD	60.50 ± 6.74	68.58 ± 6.52	-3.260 ^b	0.003	HS
	Range	49–71	55–73			
Gender	Female	9 (50.0%)	3 (25.0%)	1.875 ^a	0.171	NS
	Male	9 (50.0%)	9 (75.0%)			
Weight (kg)	Mean ± SD	70.61 ± 8.08	71.17 ± 9.09	-0.176 ^b	0.862	NS
	Range	60–84	59–86			
Height (m)	Mean ± SD	1.69 ± 0.09	1.69 ± 0.08	0.062 ^b	0.951	NS
	Range	1.57–1.82	1.58–1.78			
BMI (kg/m ²)	Mean ± SD	24.71 ± 1.59	24.87 ± 1.37	-0.289 ^b	0.775	NS
	Range	22.2–29	22.4–27.1			

p > 0.05: nonsignificant (NS); p < 0.05: significant (S); p < 0.01: highly significant (HS)
GLS global longitudinal strain, BMI body mass index
^a Chi-square test
^b Independent t test

lowed up 3 months after pacemaker implantation.

When comparing the non-apical pacing group with the apical pacing group regarding investigational data 3 months after pacemaker implantation, we found a statistically significant difference in radial dyssynchrony between the two groups (p < 0.001). It was found that radial dyssynchrony was more affected in the apical

location than in the non-apical location (radial dyssynchrony: 108.67 ± 11.68 vs. 80.53 ± 8.17 ms). There was a difference in radial dyssynchrony (50.53 ± 13.30 ms) in the apical pacing group, which was greater than that in the non-apical pacing group (29.87 ± 6.64 ms).

Similarly, Djavadzadehgan et al. investigated the acute effect of RV apical and septal pacing on LV function using speckle-

tracking echocardiography and found that RV septal pacing is a better pacing alternative in terms of less LV dyssynchrony and better longitudinal functions compared to RV apical pacing [10].

In our study, there was a statistically significant increase in radial dyssynchrony for all patients after 3 months of pacing when compared with before pacing. This is concordant with similar short-term studies

Table 6 Relation between GLS deterioration and clinical data of the patients		Non-deteriorated GLS	Deteriorated GLS	Test value	<i>p</i>	Sig.
		<i>n</i> = 18	<i>n</i> = 12			
Medical history (DM, HTN)	None	10 (55.6%)	5 (41.7%)	1.190 ^a	0.755	NS
	DM	3 (16.7%)	2 (16.7%)			
	HTN	3 (16.7%)	4 (33.3%)			
	DM + HTN	2 (11.1%)	1 (8.3%)			
Device type	Dual chamber	17 (94.4%)	4 (33.3%)	12.804 ^a	0.000	HS
	Single chamber	1 (5.6%)	8 (66.7%)			
Site of RV lead	Mid-septal	10 (55.6%)	5 (41.7%)	0.556 ^a	0.456	NS
	Apical	8 (44.4%)	7 (58.3%)			
Percentage of pacing	Mean ± SD	85.33 ± 6.92	98.33 ± 3.89	-5.894 ^b	0.000	HS
	Range	80–100	90–100			

p > 0.05: nonsignificant (NS); *p* < 0.05: significant (S); *p* < 0.01: highly significant (HS)
GLS global longitudinal strain, DM diabetes mellitus, HTN hypertension, RV right ventricular
^a Chi-square test
^b Independent *t* test

[11, 12]. Inoue et al. conducted the same study with 7 days follow-up of echocardiography parameters and found the same results favoring septal pacing [11]. Teima et al. also carried out a short-term study for 1 year with follow-up of echocardiographic parameters for patients with dual-chamber and single-chamber pacemakers. They found a significant decrease in LV function by both EF and GLS by speckle tracking [12].

In another study, by Baronaite-Dūdonienė et al., 30 patients with dual-chamber pacemakers were followed up at 3 months. Patients were divided into an apical pacing group and a non-apical pacing group; GLS decreased significantly in all patients and the study showed that pacing lead position did not prevent LV desynchronization [13]. These findings were similar to ours, in which GLS and radial dyssynchrony showed highly statistically significant differences before and after pacing in both groups.

In a long-term study conducted by Tops et al., the effect of RV pacing on the time-to-peak radial strain of different LV segments was assessed. Speckle-tracking analysis after a mean of 3.8 ± 2 years of RV pacing was performed. There was marked heterogeneity in the time-to-peak strain of the six segments. The authors found that 57% of patients developed LV dyssynchrony, which was represented by a time difference of 130 ms between the time-to-peak strain of the anteroseptal and the posterolateral segments [14].

In these patients, deterioration in LV systolic function and NYHA functional class were observed. In 11 patients, an “upgrade” of the conventional pacemaker to a biventricular pacemaker resulted in a partial reversal of the detrimental effects of RV pacing [14]. Choudhary et al. also conducted a long-term study for 40 months comparing apical and septal pacing. They followed up patients with EF assessment and found that LVEF decreased in an apical location more than in a non-apical location [15].

In our study, there were 12 patients with GLS deterioration after 3 months follow-up, which represents 40% of the study patients with no statistically significant difference between the non-apical pacing group and the apical pacing group. Regarding demographic data, older age had a statistically significant relationship with GLS deterioration (*p* = 0.003) as did single-chamber pacemaker (*p* < 0.001), and also a higher percentage of pacing, i.e., 90%–100%, had a statistically significant relationship with GLS deterioration (*p* < 0.001).

These factors can be used as prognostic factors for pacing-induced cardiomyopathy. This is concordant with the study conducted by Zhang et al., which examined the prognostic factors of pacing-induced cardiomyopathy. They showed that ventricular pacing percentage, device type, and patient age were prognostic factors for PICM and that ventricular pacing percentage was the most sensitive prognostic factor for PICM [16].

Limitations

The limitations of this study include its relatively small sample size, which makes statistical analyses difficult to conduct and interpret (low statistical power). Furthermore, it was a single-center study. The duration may not have been long enough to study some factors that may have affected the study. Speckle tracking-based parameters including dyssynchrony and global strain and strain rate depend on the echocardiographic image quality itself. Therefore, we had to exclude cases with suboptimal echocardiographic images that resulted in tracking failure.

Conclusion

Through the analysis of 2D speckle tracking echocardiography, in the short-term follow-up, we found that radial dyssynchrony was more frequent in the apical location than in the non-apical location of the RV lead. Furthermore, RV septal pacing is a better alternative in terms of less dyssynchrony compared with RV apical pacing. Older age, higher percentage of pacing, and device type are prognostic factors for the development of pacemaker-induced cardiomyopathy.

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Declarations

Conflict of interest. A.N. Ali, A.N. Hawas, A.Y. Ramadan and A.F. Tamara declare that they have no competing interests.

This study was approved by Ain Shams University ethical committee according to the ethical guidelines of the 1975 declaration of Helsinki as revised in 2008. An informed consent was obtained from all patients prior to their inclusion in the study.

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Einfluss der rechtsventrikulären Elektrodenposition auf linksventrikuläre Funktionen und frühes Remodeling bei permanenten Ein- und Zweikammerschrittmachern

Hintergrund: Durch rechtsventrikuläre (RV) apikale Schrittmachertherapie kann sowohl eine interventrikuläre Dyssynchronie als auch eine intraventrikuläre Dyssynchronie ausgelöst werden. Eine mechanische Dyssynchronie nach apikaler Langzeit-RV-Schrittmachertherapie geht mit einer verminderten linksventrikulären (LV) systolischen Funktion und Verschlechterung der funktionellen Kapazität einher. **Ziel:** Ziel der Arbeit war es, die kurzfristigen Auswirkungen der RV-Elektrodenposition des Schrittmachers auf das Remodeling systolischer LV-Funktionen zu ermitteln.

Patienten und Methoden: In die Studie wurden 30 Patienten einbezogen, die sich mit einer Indikation für eine permanente Schrittmachertherapie vorstellten und bei denen die Implantation eines permanenten Ein- oder Zweikammerschrittmachers erfolgte: 15 Patienten mit apikaler RV-Schrittmachertherapie (RV-Apex) und 15 Patienten mit nichtapikaler Schrittmachertherapie (mittseptal). Die zweidimensionale (2-D-)Speckle-Tracking-Echokardiographie wurde zur Quantifizierung der globalen longitudinalen Funktion des LV und zur Beurteilung einer Dyssynchronie vor der Schrittmacherimplantation und nach 3-monatiger Nachbeobachtung eingesetzt.

Ergebnisse: Bei der Nachuntersuchung nach 3 Monaten zeigte sich in der 2-D-Speckle-Tracking-Echokardiographie nach Schrittmachertherapie eine Beeinträchtigung des globalen longitudinalen Strains bei allen Patienten, und die intraventrikuläre Dyssynchronie war bei apikaler Lokalisation signifikant größer als bei nichtapikaler Lokalisation (radiale Dyssynchronie: $108,67 \pm 11,68$ ms vs. $80,53 \pm 8,17$ ms; $p < 0,001$), es bestand ein größerer Unterschied ($50,53 \pm 13,30$ ms) bei apikaler Lokalisation als bei nichtapikaler Lokalisation ($29,87 \pm 6,64$ ms; $p < 0,001$).

Schlussfolgerung: Im Rahmen der kurzfristigen Nachbeobachtung ergab die 2-D-Speckle-Tracking-Echokardiographie eine stärkere radiale Dyssynchronie bei apikaler Lokalisation als bei nichtapikaler Lokalisation der RV-Elektrode. Die septale RV-Schrittmachertherapie stellt eine bessere Alternative in Bezug auf eine geringere Dyssynchronie im Vergleich zur apikalen RV-Schrittmachertherapie dar. Höheres Alter, ein höherer Anteil an Schrittmacheraktionen und der Gerätetyp sind prognostische Faktoren hinsichtlich der Entstehung einer schrittmacherinduzierten Kardiomyopathie.

Schlüsselwörter

Apikale Stimulation · Dyssynchronie · Globaler longitudinaler Strain · Schrittmacherinduzierte Kardiomyopathie · Speckle-Tracking-Echokardiographie