The Egyptian Journal of Hospital Medicine (Jan. 2016) Vol. 62, Page 51- 56

Radiofrequency Catheter Ablation of Premature Ventricular Beats among Egyptians: Predictors of Success and Recurrence

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ABSTRACT

Background: Premature ventricular beats (PVBs) are early depolarization of the myocardium originating in the ventricle, the prognosis in patients with frequent PVBs and no obvious organic heart disease is usually very good. However, many patients are severely symptomatic with impaired quality of life.

Aim of the study: We aimed at our study to assess the success of radiofrequency catheter ablation of monomorphic PVB and its impact on improvement of left ventricular (LV) systolic functions.

Patients and Methods: The current study was conducted on 40 patients with frequent symptomatic monomorphic PVBs, candidate for PVB radiofrequency catheter ablation in cardiology department, Ain Shams University, between 2013 and 2015. All patients were subjected to thorough history taking, complete general and local examination, conventional 2D echocardiography and pre-procedural Holter ECG monitoring. Patients were divided to two groups (20 patients in each group) according to the presence or absence of structural heart disease. Electrophysiological mapping and ablation was done for all patients, and their clinical, electrophysiological and procedural aspects were analyzed. Follow up echocardiography and Holter ECG monitoring was done 3-6 months later to assess recurrence and impact on LV internal dimensions and systolic functions.

Results: Acute success was achieved in 35 patients (87.5%), and long term success was achieved in 30 patients (75%), with elimination of PVBs and distressing symptoms among group of patients with procedural success. Presence of structural heart disease was not related statistically to procedural failure or long term recurrence. Magnitude of reduction of PVB burden had significant correlation with improvement of systolic functions (P=0.04). Significant improvement of echocardiographic parameters was witnessed among group with baseline LV systolic dysfunction.

Conclusions: Radiofrequency catheter ablation is an effective and safe therapeutic tool for frequent monomorphic PVBs and should be addressed as 1st line option for reversal of PVB induced LV systolic dysfunction.

Keywords: PVB, electrophysiology, radiofrequency ablation.

INTRODUCTION

Premature ventricular beats (PVBs) are early depolarization of the myocardium originating in the ventricle. They are often seen in association with structural heart disease and represent increased risk of sudden cardiac death (SCD), yet they are ubiquitous, even in the absence of identifiable heart diseases. They may cause troubling and sometimes incapacitating symptoms such as palpitation, chest pain, pre-syncope, syncope, and heart failure.[1]

PVBs originating in the ventricular outflow tract usually appear in patients without structural heart disease. They may present in the form of isolated or incessant PVBs, or as tachycardia (up to 80% of idiopathic ventricular tachycardia). The main causal mechanism is triggered activity, but re-entry or abnormal automaticity mechanisms have also been postulated.[2] Beta blockers or Verapamil usually show only limited effectiveness in controlling this type of PVB. Radiofrequency ablation can be effective, but is hampered by the fact that this PVB has limited and unpredictable inducibility.[3]

Aim of the study: To assess the efficacy of radiofrequency catheter ablation of monomorphic PVBs using different mapping techniques in presence or absence of structural heart diseases.

PATIENTS AND METHODS

This study was prospective comparative study conducted on fourty patients with symptomatic monomorphic PVBs; patients were divided into two equal groups

Received: 01/01/2016
Accepted: 15/01/2016
DOI : 10.12816/0021413

according to the presence or absence of structural heart disease. In the current study, patients with documented monomorphic PVBs who are symptomatic despite medical treatment with PVB burden above 10% were included.[4].

All patients were subjected to thorough history taking and physical examination. Trans-thoracic echocardiography was done to assess LV dimensions and systolic functions. Holter ECG monitoring was done also to assess baseline PVB burden. Electrophysiological mapping and ablation was done in Ain Shams university hospitals, after informed consent using local anesthesia. Initial prediction of PVB origin was performed using 12 lead surface ECG with the aid of different algorithms as V2 transition ratio, R wave duration index and PVB transition which is later confirmed with intra-cardiac mapping. 3D electro-anatomical mapping modalities were used in 22 subjects.

Acute success was defined as disappearance of PVB at the end of the procedure or less frequent than single PVB per minute or 30 beats per 30 minutes. Follow up was done after 3-6 months using trans-thoracic echocardiography and 24 hours Holter ECG to assess long term success, which is defined as reduction of PVB burden by over 75% and disappearance of PVB related symptoms.[5] Pre-procedural and post-procedural echocardiographic parameters were analyzed and compared to assess impact of procedural success in reversal of LV dysfunction.

Statistical analysis

Results were analyzed by statistical package for social sciences (SPSS) Data were expressed as mean ± SD and percentage.

RESULTS

The studied population had a mean age of 39.95 yrs, 57.5% of patients were males, and the mean duration of symptoms was 5.8 yrs, the most frequent complaint was palpitations followed by SOB and rarely syncope.

Intra-cardiac mapping was done using either conventional EP mapping or 3D electro-anatomical mapping for accurate localization of PVBs, showing 8 cases with PVB origin from RVOT posterior septum (20%), 3 cases from RVOT anterior septum (7.5%), 5 cases from RVOT posterior free wall (12.5%), one case from RVOT anterior free wall (2.5%), one case from sub-aortic portion of LVOT (2.5%), 15 cases from LCC (37.5%), one case from RCC (2.5%), 3 cases from LCC-RCC junction (7.5%), one case from LV postero-medial papillary muscles (2.5%), one case from tricuspid annulus (2.5%), and one case of Para-hissian origin (2.5%).

Multivariate stepwise logistic regression analysis was used to predict RVOT origin from the surface ECG using different algorithms, including PVB transition, R/S ratio, and R wave duration index, showed that R wave duration index was the only significant independent predictor for RVOT origin with cut off value of < 3 ($P=0.0057$).

Regarding electrophysiological procedural details, 18 patients underwent conventional mapping, PVB origin was from RVOT in 9 patients and LVOT and aortic sinuses in 9 patients, while twenty two patients underwent 3D electro-anatomical mapping, in which PVB origin was from RVOT in 8 patients, LVOT and aortic sinuses in 11 patients and other sites in 3 patients. As regards 3D electro-anatomical mapping modalities, mapping was done using CARTO 3 system in 18 patients using Thermocool-Navistar 3.5mm 8F catheters, while the Ensite NavX system was used in 4 patients using Cool Path™ Duo 4mm Ablation Catheters.

There was a statistically significant relation between PVB origin assumed by 12 lead surface ECG and acute success, in which no reported failure was encountered in non LVOT sites while all the 5 cases of acute failure were localized in the LVOT and aortic sinuses (P value=0.03). A statistically significant difference was found regarding PVB transition in chest leads, in which all patients with acute success had PVB transition between V3 and V6, while four patients with acute failure had PVB transition in V1, and the remaining case with acute failure had transition in V2 (P value=0.004).

No statistically significant relation was found between PVB origin and recurrence, from the whole five cases of recurrence, three cases were localized in RVOT and two cases in LVOT. On comparing group of patients with long term success and group of patients with failure as regards procedural aspects, a statistically significant difference was found between the two groups regarding disappearance of PVBs at the end of the procedure, ablation temperature and drop of impedance at ablation site (P value =0.0001, 0.002, 0.002, respectively).

Presence of structural heart disease had statistically significant relation with non RVOT PVBs, as thirteen patients with LVOT PVBs had structural heart disease and two patients out of three with non outflow PVBs had structural heart disease (P value=0.04).

Regarding procedural aspects, fifteen patients with structural heart disease underwent 3D electro-anatomical mapping while five patients underwent conventional EP study. Presence of structural heart disease was associated with longer mean procedural time and fluoroscopy time as compared to patients with structurally normal heart, with (P value=0.02, 0.039) respectively, otherwise there was no statistically significant difference between the two groups in other procedural parameters. Regarding acute success, long term success and procedural complications, no statistically significant difference was found with structural heart disease.

Lower PVB burden at FUP was associated with significant improvement of EF (≥5%), (P value = 0.03). In the cohort of patients with baseline LV systolic dysfunction (N=14), a comparison was made between group of patients who achieved long term success (N=10) and group of patients with recurrence (N=4), revealing that 70% of patients who achieved long term success and 50% of patients with recurrence had ≥5% post-procedural improvement in EF, with no statistically significant difference (P value of 0.48).

DISCUSSION

A unique finding in the studied population was the LVOT origin of PVBs which occurred in 50% of patients, followed by the RVOT (42.5%) and non-outflow PVB origin including Para-hissian origin, tricuspid annulus and postero-medial papillary muscle (7.5%). In contrary to the study conducted by ***Bogun et al***, in which RVOT was the origin in 52% of patients followed by LVOT in 13%.[6]

Among the different algorithms for PVB localization, is the V2 transition ratio, which is applied for localizing outflow tract PVBs with cut off value of ≤0.58 to predict RVOT origin with sensitivity of 88.24% and specificity of 87.50%. In the study conducted by ***Betensky et al*** on 40 patients with outflow tract PVBs, the V2 transition ratio was significantly greater for LVOT PVBs compared with RVOT PVBs (1.27 ± 0.60 vs. 0.23 ±0.16) and a V2 transition ratio ≥0.60 predicted an LVOT origin with 95% sensitivity and 100% specificity.[7]

R wave duration index with cut off value <0.3 predicted RVOT origin of PVB with sensitivity of 82.35% and specificity of 76.47%, and R/S ratio with cut off value of <0.28 predicted RVOT PVBs. In the study conducted by ***Zhang et al***, R wave duration index of less than 0.5 and the R/S wave amplitude index of less than 0.3 predicts RVOT-PVBs with 94.87 sensitivity and 100% positive prediction value.[8]

Acute success was defined as disappearance of clinical PVBs or sporadic PVBs less than one per minute by the end of the procedure, which was achieved in 35 patients (87.5%). This is consistent with experience at various centers around the globe, where success rates have been variously reported between 75-100%. ***Yarlagadda et al*** achieved successful ablation in 23 (85%) patients out of 27 patients.[9] Another series included 40 patients and conducted in Japan by ***Takemoto et al***. achieved successful ablation in 37 patients (93%) of the total patients.[10]

Long term success was defined as improvement of PVB related symptoms, with disappearance of PVBs or reduction in number by over 75% in 24 hours Holter ECG monitoring done 3 to 6 months later, five cases were announced to have recurrence, with long term success achieved in 30 patients (75%).

In the study conducted by ***Takemoto et al***, recurrence occurred in single patient with RVOT PVB, with long term success of 97%, while in the series conducted by ***Yokokawa et al.***, recurrence occurred in 10 patients with long term success of 90%.[11]

The lower the PVB burden at follow up, the more is the improvement of LVEF, mean PVB burden was 1.42±1.97% among group of patients with considerable post-procedural improvement of EF, while it was 7.88±12.52% among the other group, also significant correlation existed between magnitude of reduction of PVB burden and magnitude of improvement of EF, P=0.04. This finding was confirmed by ***Bogun et al***, in his study on 60 patients with monomorphic PVBs, including 22 subjects with cardiomyopathy, he postulated an inverse relation between PVB burden and LVEF. In the study conducted by ***Baman et al***, on 174 patients with idiopathic monomorphic PVBs, including 57 patients with cardiomyopathy, PVB burden was independently associated with cardiomyopathy with cut of value of burden >24%.[12]

We concluded that radiofrequency catheter ablation is an effective and safe tool for treatment of monomorphic symptomatic PVBs and improving LV performance in subjects with PVB induced LV dysfunction.

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Table (1): ECG, ECHO and Holter parameters of studied population

ECG parameters	Acute success N= 35	Acute failure N =5	P value
PVB transition			
V1 (N)	4	4	0.004
V2 (N)	1	1	
V3 (N)	15	0	
V4 (N)	10	0	
V5 (N)	2	0	
V6 (N)	3	0	
Echocardiographic parameters			
Pre-procedural LVEDD (mm)Mean±SD	52.48±8.39	58.60±10.71	0.14
Pre-procedural LVESD (mm) Mean±SD	36.42±8.47	41.20±10.25	0.25
Pre-procedural EF (%) Mean±SD	58.65±12.36	53.40±13.88	0.38
Post- procedural LVEDD (mm) Mean±SD	48.91±5.97	57.60±10.31	0.009
Post-procedural LVESD (mm) Mean±SD	33.05±6.38	40.40±9.83	0.03
Post-procedural EF (%) Mean±SD	60.05±10.34	54.40±13.57	0.10
Holter ECG parameters			
Pre-procedural PVB burden (%)Mean±SD	26.59±9.75	25.08±11.67	0.75
Pre-procedural PVB (N) Mean±SD	28986.9±9651.88	33253.6±24506.3	0.71
Pre-procedural Bigeminy cycles (N) Mean±SD	5465.06±9149.68	1419.80±1380.58	0.33
Pre-procedural Couplets (N) Mean±SD	431.37±979.5	4822.60±6526.52	0.20
Pre-procedural NSVT (N) Mean±SD	80.40±231	172±255.75	0.41
Pre-procedural VT (N) Mean±SD	0.85±0.28	11.60±25.93	0.37
Post-procedural PVB (N) Mean±SD	1746.40±4296	32858±29983.1	0.12
Post-procedural Bigeminy cycles (N) Mean±SD	32.57±113.11	306±429.39	0.29
Post-procedural Couplets (N) Mean±SD	11.25±30.17	5952.50±7435.49	0.20
Post-procedural NSVT (N) Mean±SD	0.31±1.84	280±323	0.18
Difference in PVB burden (%) Mean±SD	24.77±10.65	1.67±6.46	<0.0001

Table (2): predictive value of different ECG algorithms in PVB localization

	Cut off value	AUC (95%CI)	P value	Sensitivity (%) (95%CI)	Specificity (%) (95%CI)
V2 transition ratio	≤0.58	0.888 (0.769-1.000)	<0.0001	88.24 (63.6-98.5)	87.50 (61.7-98.4)
R/S ratio	<0.28	0.856 (0.734-0.979)	<0.0001	64.71 (38.3-85.8)	94.12 (71.3-99.9)
R wave duration index	<0.3	0.858 (0.734-0.987)	<0.0001	82.35 (56.6-9.2)	76.47 (50.1-93.2)
PVB/Sinus duration	>1.8	0.956 (0.892-1.000)	<0.0001	97.06 (84.77-99.9)	83.33 (35.9-99.6)

Table (3): Comparison between group of patients with baseline LV dysfunction and group with baseline normal heart regarding echocardiographic parameters

	LV dysfunction (N = 14)	**Normal LV functions (N = 25)**	**P value**
Difference in LVEDD (mm)Mean±SD(Median)	-5.79±4.66 (-6)	-1.56±2.91 (0)	0.002
Difference in LVESD (mm)Mean±SD(Median)	-4.78±4.20 (-4)	-1.96±3.16 (-1)	0.024
Difference in EF (%)Mean±SD(Median)	5.92±3.97 (6.5)	3.20±4.60 (3)	0.04

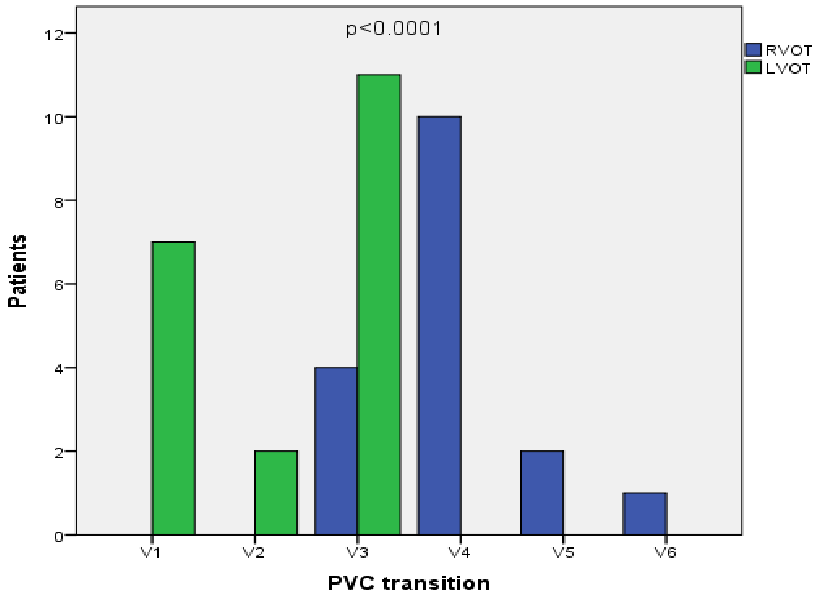

Figure (1): PVB transition in relation to PVB origin.

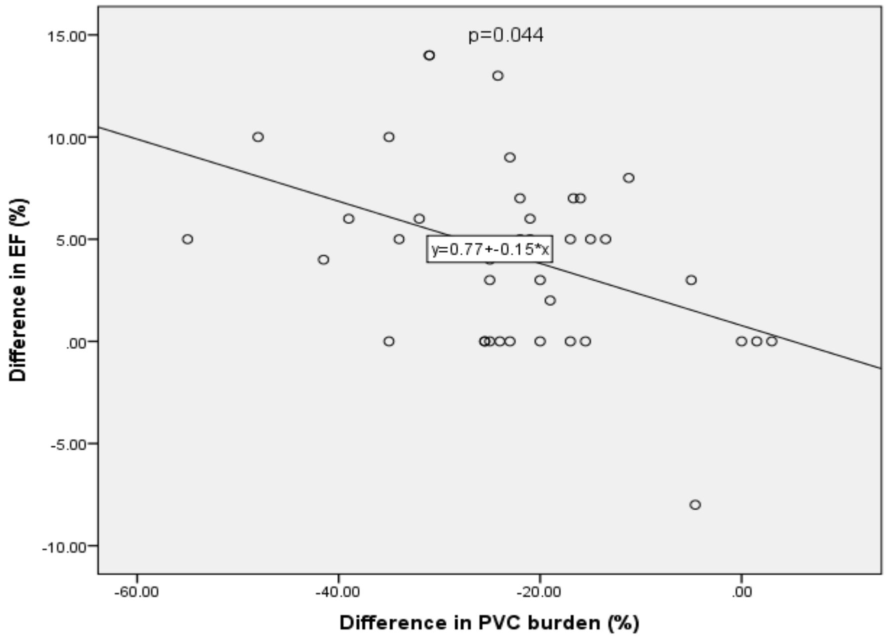

Figure (2): Correlation between difference in PVB burden and improvement of EF post-procedural.