Original Article

Right Ventricle Perforation in Permanent Pacemakers Implantation

RV Perforation in Permanent Pacemakers

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ABSTRACT

Objective: To study the right ventricle perforation in permanent pacemakers implantation.
Study Design: Retrospectively study
Place and Duration of Study: This study was conducted at the Department of Cardiology, Hayat Abad Medical Complex, Peshawar and PIMS, Islamabad from 2010 to March 2018.
Materials and Methods: According to the protocol of our center, we maintain patients' records of follow up clinic from 2nd post-operation day and then at six months to one year, interval or more frequently if they are having any symptoms. It includes patient's symptoms, pacemaker site examination, baseline ECG at arrival and patient device parameters observed on device programmer. Patients are advised echocardiography, x-ray chest postero-anterior view and lateral view and examined under fluoroscopy if there is any suspicion of complication. Data so obtained was analyzed for the frequency of lead perforation using SPSS version 22.
Results: Total 1670 different implantable devices record was examined during the study period. There were 535 dual chamber pacemakers, 1030 single chambers pacemakers, CRTP, CRTD and AICD were 45, 10 and 49 respectively. We found only one case of RV lead perforation in a dual chamber pacemaker.
Conclusion: Lead perforation in permanent pacemakers is a dreaded complication which can be best prevented by not allowing any tension on lead when it is position in the right ventricle.
Key Words: Right ventricle wall perforation, permanent pacemaker (PPM), tine lead, screwing lead, right ventricle out flow tract (RVOT).

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INTRODUCTION

As the average life expectancy increases globally[1] on one hand, and there is stat of the art management for congenital heart diseases[2] on the other hand, both these have increased the number of adult population living with heart diseases many fold around the world.[3] It not only increased the burden of outdoor cardiology patients but also burden on interventional cardiology and electrophysiology. Cardiac devices, which are the integral part of both cardiology and electrophysiology today, also increased enormously.[4] There is a new epidemic in the implantation rate of cardiac pacemakers[5], automated implantable cardiovertor defibrillators (AICD)[6], and cardiac resynchronization devices (CRT)[7] implantation. The increased rate of implantation also increased the rate of devices related complications.[8] Lead perforation is one of the dreaded complications which can endanger the life of the patients[9] beside the increased financial cost and burden on cardiac institution.[10] Though the incidence of perforation has been on the decline as the leads have become more flexible, less stiff and thinner but still it pop up in the daily practice.[11] The presenting symptoms are chest pain, dyspnoea, Syncope, abdominal pain, muscle or diaphragm stimulation and hiccups.[12] Pericardial effusion may leads to Cardiac tamponade causing hypotension, shock or even cardiac arrest, and may require surgical assistance[9] beside as emergency in the pacing department. Apart from symptomatic perforation, the rate of unrecognized and asymptomatic perforations is much higher and in some studies the incidence reaches up to 15%.[13] There is loss of capture and sensing despite the fact that the impedance of the lead is normal.[12] Pacemaker system interrogation on device programmer, echocardiography,[14] chest radiography[14] and computed tomography (CT)[15] scanning can be very helpful to either prove or rule out this complication. Once the complication is diagnosed then, there is no alternative other than to reposition the lead. But the difficulty of explanting the device and repositioning the lead will depend on the duration since implantation [12]. More the time since implantation, difficult will be the explanation due to fibrosis and adhesion[12] both inside and outside the heart. At the time

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of lead extraction, the procedure may be complicated by tamponade, and will need urgent pericardiosentesis[16] or surgery[12] to sealing the puncture site of the heart. So at the time of explanation the cardiac surgical suit needs to be informed. However, if the patient is totally asymptomatic and the device sensing and capture properties are intact then perforation is an accidental finding. The right heart which is a low-pressure system, a perforation may be sealed by a combination of muscle and fibrosis over the lead, resulting in no sequelae. Appropriate management of asymptomatic lead perforation is a debated issue. Some studies suggest that the diagnosis of lead perforation necessitates lead removal [17]. Results of other studies[16], however, suggest that the extraction of a chronically perforated lead without malfunctioning of the device is not mandatory. In addition, the risk of cardiac tamponade should be weighted after the removal of chronically implanted leads with asymptomatic perforation against the fact that a significant number of those leads which are asymptomatic and partially perforated may present with symptoms later on.[18]

Any complication can only be prevented if the cause of that complication is certainly known. But unfortunately, the exact mechanism of lead perforation is not known but different factors have been listed in the literature for lead perforation. These include: factors related to the patient, device, procedure, underlying pathology in the heart and the use of some medication by the patients at the time or after implantation. Therefore, the ratio of this cumbersome complication can be enormously reduced if these factors are address during the procedure. In this study, we are going to share our own experience in the field of implantation and the rate of lead perforation in the last one decade in our procedure.

MATERIALS AND METHODS

The record of all those patients from our pacemakers follow up clinic, who were implanted permanent pacemakers, was analyzed retrospectively for lead perforation. Patients were examined on the 2nd post operative day or after the procedure and then at six months to one year, interval or at any time if the patient was symptomatic. At each visit a brief history of any symptoms was recorded. Pacemakers' implantation site was examined at each visit and twelve lead ECG advised. Patients' device was analyzed on programmer for battery life, Impedance, threshold, atrial sensing and P wave amplitude. V sensing and R wave amplitude was also recorded if not fully dependent. Atrio-ventricular (AV) delay adjusted for possible maximum ventricular intrinsic rhythm sensing but not at the cost of hemodynamic compromised. Patients who were symptomatic were further subjected to X-Ray chest posterio-anterior and lateral view and if needed examined under fluoroscopy. All data so collected was analyzed on SPSS version 22 for frequency of perforation.

RESULTS

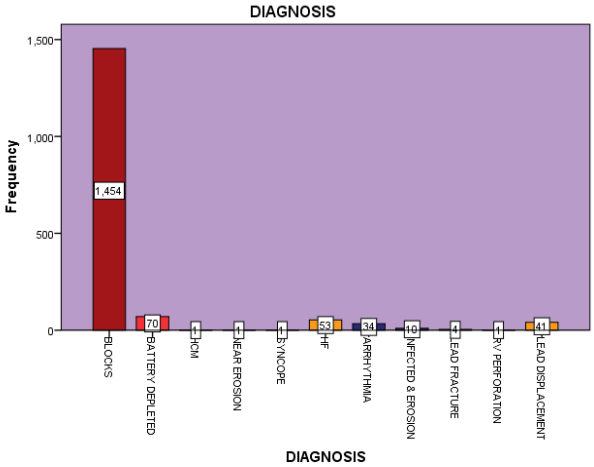

Figure No.1: Diagnosis of patient at time of presentation

Table No. 1: Demographic data of patients

No	Parameters	Frequency	%tage
1	Total procedure	1670	
2	Age limit of patient	10 to 100 yrs	
3	Male	962	57.6%
4	female	708	42.4%
5	DDD/DDDR	535	32%
6	VVI/VVVIR	1030	61.7%
7	AICD	49	2.9%
8	CRTP	45	2.7%
9	CRTD	10	0.6%
10	Reveal loop	1	0.1%
11	Tine lead	28	1.67%
12	Screwing lead	1592	95.3%
13	Tine & screwing	49	2.9%
14	Leadless	1	0.1%

Table No. 2: Complication during procedure

Complication in Procedure			
		Frequency	Percent
Valid	Lead displacement	6	.4
	Failed	3	.2
	Svc dissection	2	.1
	Mild pericardial effusion	1	.1
	Haematoma	3	.2
	Infection	3	.2
	Pneumothorax	16	1.0
	Lead damage	3	.2
	Nil	1633	97.8
	Total	1670	100.0

Total 1670 devices implantation record from April 2010 to March 2018 was analyzed. It includes single chambers pacemakers, dual chambers pacemakers, AICD, CRTP and CRTD. The demographic data of the patient is presented in table 1. There were 962 (57.6%)

male and 708(42.4%) female patients. The ages of the patients were from 10 years to 100 years with Std. deviation of ± 16.361. The diagnosis at the time of implantation is shown graphically in figure 1. The rate of complication is presented in table 2. We got one patient with RV lead perforating RV apex. Patient presented with last of captured.

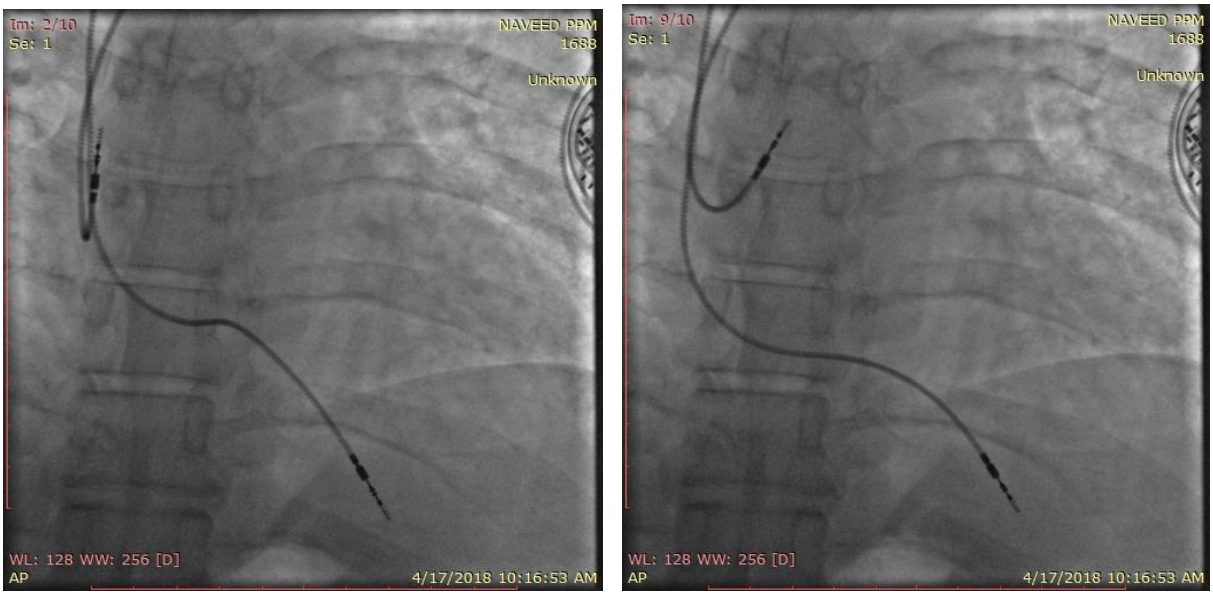

Figure No. 2: RA lead; the vector of force is from side to side i.e. perpendicular to the tip of the lead.

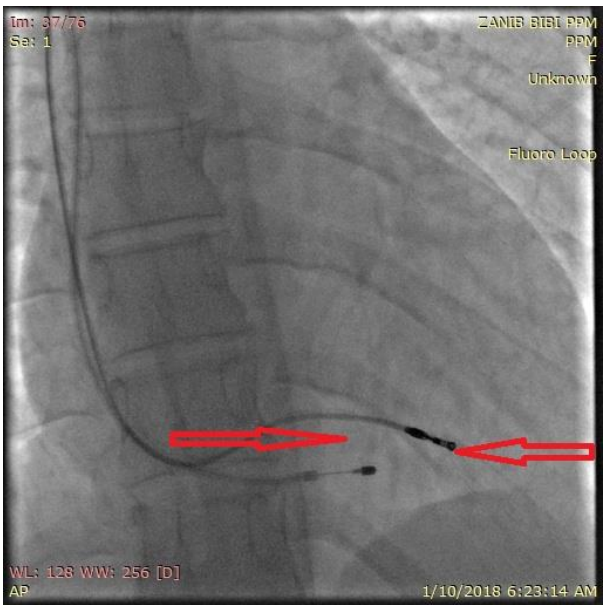

Figure No. 2: RV lead; the direction of the vector of force is toward the tip

DISCUSSION

Cardiac perforation by pacemaker lead is a potentially fatal complication. The incidence of lead perforation has been reported from 0.4% up to 5.2% and in some reports even up to as high as 15%.[13] The highest reported rate of perforation, based on autopsy, was 27% for patients with atrial leads.[19] The perforation is classified on the basis of duration since implantation. Perforations are labeled as acute; when it is occurring within 24h after implantation. It is labeled as sub-acute and chronic when the duration after implantation is within a month or after a month respectively.[18] The exact mechanism of lead perforation is not clear but certain factors possibly responsible in the pathophysiology of this dreaded complication.[20] The apex of RV is thinner than the RVOT, this is why, the reported perforation is more in the RV apex as compared to RVOT.[21] But contrary to this finding there are report of more perforation of RVOT as compared to RV apex.[22] Similarly RV wall which is about two times thicker than right atrium, logically one would anticipate a higher risk of atrial wall perforation. But there are report of more RV perforation as compared to RA, [22] certainly the underlying mechanism is not cardiac muscle mass nor the lead structure, but possibly the lead shape, while implanted in the cavity and the internal forces of the RA and RV and mechanism of contraction. The RV force is more as compared to the RA and the mechanism of contraction toward the lead is totally different. In RA the force is not on the tip of the lead but it is from side to side on the U shape cure of the RA lead figure 1. The reported incidence of autopsy for RA[13] was most of the time asymptomatic patients, so the possible cause was over screwing of the lead at the time of implantation which went unnoticed at the time of implantation and remain without any sequelae. On the other-hand the systolic force of the RV lead is directly transferred to the tip of the lead, which forces the lead to penetrate the tissue. Both these factors

can be modified by not too much screwing the lead and by implanting the RV lead in such a way that the distal part of the lead is turn down 2 to 3 centimeter proximal from the tip of lead, so the force of contraction will not directly force the lead to penetrate the heart: figure 2. Now if we consider RV apex to RVOT, mostly it is the apex which is consider the most vulnerable area for peroforation.[20] But some studies are against this and people have found that RVOT is the most perforated area as compare to the apex,[21] therefore it can be said that the U shape of the lead in the RVOT, which will divert the vector of the force of contraction, on one hand and the thicker muscular wall of the RVOT on the other hand, are not going to prevent the perforation. Here the possible mechanism is the whole force of the RV which accumulate toward the RVOT on one side and the long cure of the lead which force the tip to penetrate on the other side. If the tip of the lead is screwed in way that instead of the RV force reach directly to the tip, it is absorbed by a small curve near the tip, the concentration of force can be diluted. The two other factors which can force the lead are: the pacemaker lead stucture[23]and over torquing of the leads.[24] Some leads design were reported to be associated with more perforation than others, possibly due to the stiffness of the lead and the tip configuration.[25] Torque on the lead increased pressure force exerted by the thin pacemaker leads tip per unit of the ventricular wall and the imbalance between the pacemaker lead tip and the torque of the lead leads to RVOT perforation[9, 19] These two factors are modifiable factors. Torque should be not more than adequate and lead with very smart tip should be avoided. Apart from these factors, several studies have reported various factors that serve as predictors of lead perforation. These include temporary leads for long duration, steroid use, active fixation leads, low body mass index (<20 kg/m^2), older age, female gender, and concomitant use of anticoagulation.[26]

In our study we had only one patient who was having symptomatic perforation, we may have had possibly asymptomatic lead perforation but since we have no evidence, so we presume that the rate of perforation in our study remain very low. Therefore if we review all those factors responsible for the perforation of RV by pacemakers' lead, most of them can be very will tackle, if one remains vigilant during the procedure and it will help in the prevention of this dreaded complication.

CONCLUSION

Cardiac perforation by pacemaker lead is potentially a fatal complication. There is no single one factor responsible for the perforation of the heart due to permanent pacemaker's leads. However most of these factors can be modified if these factors are kept in mind at the time of implantation. This is how we can minimize the rate of this complication if not totally eliminate it.

Author's Contribution:

Concept & Design of Study:	Bakhtawar Shah
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Revisiting Critically:	Shahab Saidullah, Bakhtawar Shah
Final Approval of version:	Bakhtawar Shah

Conflict of Interest: The study has no conflict of interest to declare by any author.

REFERENCES

1. Kontis V, Bennett JE, Mathers CD, Li G, Foreman K, Ezzati M. Future life expectancy in 35 industrialised countries: projections with a Bayesian model ensemble. Lancet 2017; 389 (10076):1323-1335.
2. Gross RE, Hubbard JP. Surgical ligation of patent ductus arteriosus: A report of first successful case. J Am Med Assoc 1939;112:729–731.
3. Verjans R, van Bilsen M, Schroen B. MiRNA Deregulation in Cardiac Aging and Associated Disorders. Int Rev Cell Mol Biol 2017;334: 207-263.
4. Imai K. Perioperative management for the prevention of bacterial infection in cardiac implantable electronic device placement. J Arrhythm 2016;32(4):283-6.
5. Auricchio A, Regoli F, Conte G, Caputo ML. Key Lessons from the ELECTRa Registry in the Modern Era of Transvenous Lead Extraction. Arrhythm Electrophysiol Rev 2017;6(3):111-113.
6. Wilkoff BL, Aurricchio A, Brugada J, Cowie M, El lenbogen KA, Gillis AM, et al HRS/EHRA expert consensus on the monitoring of cardiac electronic implantable devices (CIEDs): description of techniques indications, personnel, frequency, and ethical considerations. Heart Rhythm 2008;5: 907–925.
7. Boriani G, Berti E, Belotti LM, Biffi M, Carboni A, et al. RERAI (Registry of Emilia Romagna on Arrhythmia Interventions) Investigators Cardiac resynchronization therapy: implant rates, temporal trends and relationships with heart failure epidemiology. J Cardiovasc Med (Hagerstown) 2014;15(2):147-54.
8. Poole JE, Gleva MJ, Mela T, Chung MK, Uslan DZ, Borge R, et al. Holcomb R; REPLACE Registry Investigators. Complications rates associated with pacemaker or implantable cardioverter-defibrillator generator replacements

and upgrade procedures: results from the replace registry. Circulation 2010; 122(16):1553-61.
9. Nichols J, Berger N, Joseph P, Datta D. Subacute right ventricle perforation by pacemaker lead presenting with left hemothorax and shock. Case Rep Cardiol 2015; 2015.
10. Tobin K, Stewart J, Westveer D, Frumin H. Acute complications of permanent pacemaker implantation: their financial implication and relation to volume and operator experience. Am J Cardiol 2000; 85: 774–776.
11. Akbarzadeh MA, Mollazadeh R, Sefidbakht S, Shahrzad S, Bahrololoumi Bafruee N. Identification and management of right ventricular perforation using pacemaker and cardioverter-defibrillator leads: A case series and mini review. J Arrhythm 2017; 33(1):1-5.
12. Greenberg S., Lawton J., Chen J. Right ventricular lead perforation presenting as left chest wall muscle stimulation. Circulation 2005;111: e451–e452.
13. Laborderie J, Barandon L, Ploux S, et al. Management of subacute and delayed right ventricular perforation with a pacing or an implantable cardioverter-defibrillator lead. Am J Cardiol 2008;102:1352–1355.
14. Yavari A, Khawaja ZO, Krishnamoorthy S et al (2009) Perforation of right ventricular free wall by pacemaker lead detected by multidetector computed tomography. Europace 11:252–254.
15. Amara W, Cymbalista M, Sergent J. Delayed right ventricular perforation with a pacemaker lead into subcutaneous tissues. Arch Cardiovasc Dis 2010; 103:53–54.
16. Hirschl D, Jain VR, Spindola-Franco H, Gross JN, Haramati LB. Prevalence and characterization of asymptomatic pacemaker and ICD lead perforation on CT. Pacing Clin Electrophysiol 2007;30(1): 28-32.
17. Khan MN, Joseph G, Khaykin Y, Ziada KM, Wilkoff BL. Delayed lead perforation: a disturbing trend. Pacing Clin Electrophysiol 2005;28: 251-3.
18. Banaszewski M, Stępińska J. Right heart perforation by pacemaker leads. Arch Med Sci 2012;8(1):11-3.
19. Piekarz J, Lelakowski J, Rydlewska A, Majewski J. Heart perforation in patients with permanent cardiac pacing – personal observations. Arch Med Sci 2012; 8: 70-4.
20. Ishikawa K, Cida K, Taniguchi T, et al. Myocardial perforation and/or penetration by a permanent endo cardial electrode of the pacemaker in autopsy cases. J Arrhythmia 1999; 15: 29-44.
21. Banaszewski M, Stępińska J. Right heart perforation by pacemaker leads. Arch Med Sci 2012;8(1):11-3.
22. Piekarz J, Lelakowski J, Rydlewska A, Majewski J. Heart perforation in patients with permanent cardiac pacing – personal observations. Arch Med Sci 2012;8:70-4.
23. Danik SB, Mansour M, Heist EK, Ellinor P, Milan D, Singh J, et al. Timing of delayed perforation with the St. Jude Riata lead: a single-center experience and a review of the literature. Heart Rhythm 2008;5(12):1667-72.
24. Ishikawa K, Cida K, Taniguchi T, et al. Myocardial perforation and/or penetration by a permanent endo cardial electrode of the pacemaker in autopsy cases. J Arrhythmia 1999;15: 29-44.
25. Lloyd MS, Shaik MN, Riley M, Langberg JJ. More late perforations with the Riata defibrillator lead from a high-volume center: an update on the numbers. Pacing Clin Electrophysiol 2008; 31(6):784-5.
26. Sterliński M, Przybylski A, Maciag A, Syska P, Pytkowski M, Lewandowski M, et al. Subacute cardiac perforations associated with active fixation leads. Europace 2009;11(2):206-12.