



Prevalence of cardiomyopathy following pacemaker insertion in an Iranian population; a cross-sectional study

Faezeh Dehghani Tafti¹, Seyed Mostafa Seyed Hossaini¹, Mohammad Jafari-Naeimi¹,
Danial Chaleshi², Hossein Lojje^{2,*}

¹ Yazd Cardiovascular Research Center, Non-communicable Diseases Research Institute, Shahid Sadoughi University of Medical Sciences, Yazd, Iran

² Trauma Research Center, Shahid Sadoughi University of Medical Sciences, Yazd, Iran

*** Corresponding Author:**

Address: Saman Alley, Anbia St, Mehravaran, Yazd, Iran. **Postal code:** 8915895264; **Tel:** +98 09135366163; **Email:** hosseinlojje@yahoo.com

Article Information:

Received: 09 May 2024; Revised: 03 Aug 2024; Accepted: 07 Aug 2024

DOI: 10.18502/cbj.v4i1.16223

Abstract

Objectives: This study aimed to determine the prevalence of pacemaker-induced cardiomyopathy in patients with pacemaker implantation and to identify the associated risk factors.

Methods: This cross-sectional study examined all patients who were implanted with a pacemaker at Afshar Hospital Yazd in 2019 and wore it for two to three years. A new EF test was performed for all patients and compared with the old EF. If a reduction in EF of more than 10% was observed, or the EF was less than 50% due to another reason, it was considered HF. All data were analyzed using SPSS, version 22.

Results: One hundred eleven patients participated in this study, 52 (46.8%) men and 59 (53.2%) women. The results showed that ejection fraction (EF) was more than 50% in 93 patients (83.8%). The mean EF decreased from 62.1 to 36.2% over three years. Statistical analysis showed that there is a significant association between diabetes and the incidence of cardiomyopathies in these patients ($p = 0.016$), but there was no association with hypertension. The mean length of the QRS wave in the electrocardiogram was significantly longer in the group with cardiac pacemakers than in the other patients ($P = 0.49$).

Conclusions: We concluded that 22.5% of referring patients with implantation of a right ventricular pacemaker will develop cardiomyopathy within 2-3 years.

Keywords: Cardiomyopathies, Pacemaker, Prevalence

Introduction

Cardiac pacing has become a common treatment for symptomatic bradycardia or profound atrioventricular block. The number of pacemaker implantations has increased exponentially in recent years, particularly among older people (1). As technological advances increase, the use of pacemakers has also increased (2), and permanent pacemaker insertion rates and prevalence

continue to develop with the aging population (3). The implantation of a pacemaker is a minor surgical procedure, but complications and technical failures can occur in time (4, 5). One of these complications is dilated cardiomyopathy (DCM), which can develop over time (6-8). Some clinical trials have shown that pacemakers can lead to heart failure (HF) with reduced left ventricular ejection fraction (LVEF)

(9-11). When a pacemaker is implanted, it creates an electrical pattern similar to the left bundle branch block that can cause delayed activation of the LV free wall and a prolonged QRS wave, which can lead to systolic dysfunction, LV dilatation, and clinical HF (12-14).

A comprehensive epidemiological investigation could lead to a deeper understanding of the risk of HF in patients with a pacemaker. Furthermore, such a study would shed light on the factors associated with HF risk and provide insights into the overall scope and importance of this problem. This study aimed to determine the prevalence of cardiomyopathy in patients with pacemaker implantation and to determine the associated risk factors.

Materials and Methods

This cross-sectional study examined all patients implanted with a pacemaker at Afshar Hospital Yazd in 2019 and wore a pacemaker for two to three years. The study was approved by the ethical committee of Shahid Sadoughi University of Medical Sciences, Yazd, Iran (IR.SSU.MEDICINE.REC.1402.259). The patients with EF > 50% (ejaculatory fracture) prior to surgery were included in this study. Patients with a history of cardiomyopathy, myocardial infarction, exposure to toxic agents (alcohol and chemotherapy), uncontrolled hypertension myocarditis, cardiac bundle branch block before

pacemaker implantation, and severe valvular heart disease were excluded. The patients visited the pacemaker clinic of Yazd. All demographic information was collected. A new EF test was performed for all patients and compared with the old EF. If a reduction in EF of more than 10% was observed or if the EF was less than 50%, due to another reason, it was considered as cardiomyopathy. In addition, the mean length of the QRS wave in 12 ECG leads was measured. The data were analyzed using SPSS, version 22, and a t-test was used for the analysis.

Results

In this study, patients having a pacemaker implanted 2 to 3 years ago were visited and underwent echocardiography. A total of 111 patients, comprising 52 men (46.8%) and 59 women (53.2%), were included in the study. The average age of the patients was 68.35 ± 14 years. The results indicated that 93 patients (83.8%) had an ejection fraction (EF) greater than 50%. Nine patients (8.1%) had mild left ventricular (LV) dysfunction, while six patients (5.4%) had moderate LV dysfunction, and three (2.7%) had severe LV dysfunction. Overall, different levels of cardiomyopathy were detected in 22.5% of patients (25 individuals). Among these patients, 13 had HF with reduced ejection fraction (HFrEF), and 12 had HF with heart failure mild reduced EF (HFmrEF).

Table 1. Frequency distribution of echocardiography results in patients with a history of pacemaker implantation

variable	frequency	percentage
Normal, above 50%	86	77.5%
Mild LV Dysfunction, 45 %	12	10.8%
Moderate LV Dysfunction, 35-40 %	8	7.2%
Sever LV Dysfunction, EF<30	5	4.5%
Over all Dysfunction	25	22.5%

38 out of 111 patients (34.2%) had diabetes, and 61 had hypertension (55%). Of the 25 patients with cardiomyopathy, 15 (60%) had a history of diabetes. Statistical analysis showed a significant association between diabetes and the incidence of cardiomyopathies in these patients ($p = 0.016$), but this association was not found for hypertension ($p = 0.36$). The results showed that 18 (72%) patients

had their pacemaker implanted two years ago and the rest three years ago. There was no significant difference between the two-time frames ($P = 0.43$). Furthermore, the mean length of the QRS wave in the electrocardiogram was significantly longer in patients with cardiac pacemakers compared to other patients ($P = 0.049$).

Table 2. Comparison of the cardiomyopathy incidence based on diabetes, blood pressure, duration of pacemaker implantation, age and QRS duration.

variables	Cardiomyopathy (+)	Cardiomyopathy (-)	p value
History of Diabetes	14 (56.1%)	24 (27.9%)	0.016
History of Hypertension	15 (60%)	46 (53.5%)	0.36
History of implantation 2 years ago	18 (72%)	58 (67.4%)	0.43
History of implantation 3 years ago	7 (28%)	28 (32.6%)	0.43
Age (years)	71.4 ± 11.4	68.1 ± 13.4	0.27
QRS duration (milli-second)	168.1 ± 14.9	161.4 ± 13.4	0.049

Discussion

One of the most common cardiovascular complications is cardiac arrhythmia. A temporary pacemaker can treat cardiac arrhythmias and replace regular pulses with slow or irregular heartbeats (15). The use of pacemakers in the care of patients with HF has increased over the past decade. About 3 million people have pacemakers, and each year 600,000 new ones are added (16, 17). Cardiac pacemakers are used as single-chamber and dual-chamber pacemakers for rhythm changes with cardiac arrest when the heart rate drops to less than 60 beats (30-40) (beats per minute), and the heart does not respond to tissue oxygen demand [18]. These pacemakers are implanted in the sinoatrial node or AV node to compensate for tissue hypoxia and cardiac arrhythmia, allowing patients to continue living with this device. Despite the significant technological advances in pacemaker devices and many clinical experiences related to their use, the present treatment method is not immune to complications and technical failures. Numerous studies show that most complications occur shortly after pacemaker implantation [19]. Several factors potentiate pacemaker-induced cardiomyopathy, including previous LV systolic dysfunction, right ventricular apical pacemaker, prolonged QRS, male gender, and prolonged QT interval [20].

In the present study, we investigated the prevalence of pacemaker-induced cardiomyopathy in patients. The present study showed that 22.5% of referring patients with a history of pacemaker implantation developed cardiomyopathy over 2–3 years. The average age of patients with cardiomyopathy was 70

years. From this number, the classification of HF based on EF revealed that 13 people had HFrEF and 12 had HFmrEF. The results showed that 14 (56%) of the patients with cardiomyopathy had a history of diabetes and that diabetes and pacemaker-induced cardiomyopathy had a significant association with each other.

The study by Healey et al. has shown that up to 80% of pacemakers are implanted in older people [21], and according to the research by LUCIANA et al., the average age of pacemaker wearers is 75–10 years [22]. In this regard, the average age of pacemaker implantation in the present study was 68.35 14 years. ShaanKhurshid et al. investigated the incidence of cardiomyopathies caused by the right ventricular pacemakers. Results of this study showed that out of 257 patients who met the inclusion criteria, 50 patients (19.5%) had pacemaker-induced cardiomyopathy, and their Average LVEF decreased from 62.1 to 36.2% over three years. In this context, in the present study, pacemaker-induced cardiomyopathy was observed in 22.5% of patients with a history of pacemaker implantation, and less than 30% was reported in 5.4% of EF patients [11]. Henryk Dreger et al. investigated pacemaker-induced cardiomyopathy in patients with right ventricular pacemakers.

This study showed that pacemaker-induced cardiomyopathy was observed in 4 patients (15.4%) The study found no significant association between pacemaker-induced cardiomyopathy and age, gender, pacer duration, heart rate, QRS duration, and arterial blood pressure. Similarly, in the current study, there was no significant association between

gender, age, and history of blood pressure with cardiomyopathy. It is important to note that the sample size of the subjects examined was small, which may have influenced the relationship (18).

In another study, Yu CM et al. found that most cases of cardiomyopathy caused by a right ventricular pacemaker occur in the first few years after its implantation. Furthermore, the frequency of occurrence decreases in the subsequent years (19). Similarly, in the present study, most cases of pacemaker-induced cardiomyopathy occurred in the first two years. In another study, AmrAbdin et al. showed that pacemaker-induced cardiomyopathy occurred in 26 patients (16%) (20). Additionally, this cardiomyopathy was observed more frequently in men and patients with lower arterial pressure and longer QRS. In the same line, the results of the present study showed that the QRS duration is significantly longer in the group with pacemaker-induced cardiomyopathy than in the group without cardiomyopathy. Similarly, Sung Woo Cho et al.'s study revealed that pacemaker-induced cardiomyopathy occurred in 87 patients (14.1%), and the LVEF decreased from 60.5% to 40.1% (21). The average duration of pacemaker use was 4.7 years, with LBBB and long QRS identified as independent predictors. Another aspect to take into account is that in these two studies, the pacemaker-induced cardiomyopathy is lower than in the present study, which may be due to the difference in the volume of samples examined and the duration of the study, and it may also be due to the different echocardiographic Evaluation. The study by Jun Hyung Kim et al. reported that QRS duration is the most fundamental determinant of pacemaker-induced cardiomyopathy (22). In another study,

Zhang Hong et al. found that QRS duration and atrioventricular block were significantly associated with the development of pacemaker-induced cardiomyopathy (23).

Conclusion

We concluded that 22.5% of patients implanted with a pacemaker at Afshar Hospital will develop pacemaker-induced cardiomyopathy within 2-3 years. Furthermore, individuals with a history of diabetes and longer QRS duration are at a higher risk of developing cardiomyopathy. Ethical statement: the study was approved by the ethical committee of Shahid Sadoughi University of Medical Sciences, Yazd, Iran (IR.SSU.MEDICINE.REC.1402.259).

Acknowledgments

None

Author's contributions

Mohammad, Jafari-Naeimi: Conception and design of the study, Writing - review & editing
Seyed-Mostafa Seyed-Hosseini: Writing - review & editing. Project administration, Acquisition of data.
Hossein Loje: Writing - review & editing.
Danial Chaleshi: Writing - review & editing. Project administration, Analysis
Faezeh Dehghani-Tafti: Final approval of the version to be published

Conflicts of Interest

None

Funding

None

References

1. Raatikainen MP, Armar DO, Merkely B, et al. A decade of information on the use of cardiac implantable electronic devices and interventional electrophysiological procedures in the European Society of Cardiology Countries: 2017 report from the European Heart Rhythm Association. *Europace*. 2017; 19(2):ii1-ii90.
2. Ector H, Vardas P. Current use of pacemakers, implantable cardioverter defibrillators, and resynchronization devices: data from the registry of the European Heart Rhythm Association. *EHJS*. 2007; 9(1):I44-I9.
3. Bradshaw PJ, Stobie P, Knuiman MW, et al. Trends in the incidence and prevalence of cardiac pacemaker insertions in an ageing population. *Open Heart*. 2014;1(1):e000177.
4. Marine JE, Brinker JA. Techniques of pacemaker implantation and removal. *Cardiac pacing and ICDs*. 2014:150-210.
5. Carrión-Camacho MR, Marín-León I, Molina-Doñoro JM, et al. Safety of Permanent Pacemaker Implantation: A Prospective Study. *J Clin Med*. 2019;8(1):35.
6. Udink ten Cate FE, Breur JM, Cohen MI, et al. Dilated cardiomyopathy in isolated congenital complete atrioventricular block: early and long term risk in children. *J Am Coll Cardiol*. 2001;37(4): 1129-34.
7. Moak JP, Barron KS, Hougen TJ, et al. Congenital heart block: development of late-onset cardiomyopathy, a previously underappreciated sequela. *J Am Coll Cardiol*. 2001;37(1):238-42.
8. Fukui R, Fujimoto S, Nakano H, et al. A case of dilated

- cardiomyopathy with abnormal atrioventricular conduction 5 years before the appearance of left ventricular systolic dysfunction. *Jpn Circ J.* 1997;61(4):353-7.
9. Chan JY-S, Fang F, Zhang Q, et al. Biventricular pacing is superior to right ventricular pacing in bradycardia patients with preserved systolic function: 2-year results of the PACE trial. *Eur Heart J.* 2011;32(20):2533-40.
 10. Kiehl EL, Makki T, Kumar R, et al. Incidence and predictors of right ventricular pacing-induced cardiomyopathy in patients with complete atrioventricular block and preserved left ventricular systolic function. *Heart Rhythm.* 2016;13(12):2272-2278.
 11. Khurshid S, Epstein AE, Verdino RJ, et al. Incidence and predictors of right ventricular pacing-induced cardiomyopathy. *Heart Rhythm.* 2014;11(9):1619-25.
 12. Vassallo JA, Cassidy DM, Miller JM, et al. Left ventricular endocardial activation during right ventricular pacing: effect of underlying heart disease. *J Am Coll Cardiol.* 1986;7(6):1228-33.
 13. Prinzen FW, Hunter WC, Wyman BT, et al. Mapping of regional myocardial strain and work during ventricular pacing: experimental study using magnetic resonance imaging tagging. *J Am Coll Cardiol.* 1999;33(6):1735-42.
 14. Tayal B, Gorcsan III J, Delgado-Montero A, et al. Comparative long-term outcomes after cardiac resynchronization therapy in right ventricular paced patients versus native wide left bundle branch block patients. *Heart Rhythm.* 2016;13(2):511-8.
 15. Hao Y, Li Y, Liao D, et al. Seven times replacement of permanent cardiac pacemaker in 33 years to maintain adequate heart rate: a case report. *Ann Transl Med.* 2015;3(21):341.
 16. Mallela VS, Ilankumaran V, Rao NS. Trends in cardiac pacemaker batteries. *Indian Pacing Electrophysiol J.* 2004;4(4):201-12.
 17. Elahi MM, Lee D, Dhannapuneni RRV. Predictors of permanent pacemaker implantation during the early postoperative period after valve surgery. *Tex Heart Inst J.* 2006;33(4):455-7.
 18. Dreger H, Maethner K, Bondke H, et al. Pacing-induced cardiomyopathy in patients with right ventricular stimulation for > 15 years. *Europace.* 2012;14(2):238-42.
 19. Yu C-M, Chan JY-S, Zhang Q, et al. Biventricular pacing in patients with bradycardia and normal ejection fraction. *N Engl J Med.* 2009;361(22):2123-34.
 20. Abdin A, Yalin K, Zink MD, et al. Incidence and predictors of pacemaker induced cardiomyopathy: a single-center experience. *J Electrocardiol.* 2019;57:31-34.
 21. Cho SW, Gwag HB, Hwang JK, et al. Clinical features, predictors, and long-term prognosis of pacing-induced cardiomyopathy. *Eur J Heart Fail.* 2019;21(5):643-651.
 22. Kim JH, Kang K-W, Chin JY, et al. Major determinant of the occurrence of pacing-induced cardiomyopathy in complete atrioventricular block: a multicentre, retrospective analysis over a 15-year period in South Korea. *BMJ open.* 2018;8(2):e019048.
 23. Zhang H, Zhou Y-J, Zeng Y-J. Prognostic factors of pacing-induced cardiomyopathy. *Chin Med J (Engl).* 2020;133(13):1533-1539.