

Original Article

Gender Differences and Demographics and Type of Cardiac Device over a 10-Year Period

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ABSTRACT

Aims: This study aims to review the influence of gender-specific differences and patient demographics on cardiac device and pacing mode selection over a 10-year period. **Methods:** We retrospectively reviewed patients who underwent first implantation of the cardiac device between January 1, 2006 and June 31, 2016. **Results:** During the study period, 704 patients underwent first cardiac device implantation. Number of patients undergoing pacemaker was 452 and number of patients undergoing implantable cardioverter defibrillator/cardiac resynchronization therapy and defibrillator (ICD/CRT-D) was 252. Patients undergoing pacemaker were 49.9% female with mean age 72.36±11.1. The most common indication was atrioventricular block (AVB) (84%) in both genders. The most frequently used pacing modes were VVI (70.8%), but over a 10-year period pacemaker selection shifted from VVI to DDD pacemakers. Patients undergoing ICD/CRT-D were 19.7% female with mean age 62.5±10.8. The most common indications for ICD/CRT-D was ischemic cardiomyopathy (ICMP) (55.0%). The rate of male patients was higher in patients who have received device therapy for dilated cardiomyopathy (DCMP) or ICMP, whereas the rate of female patients was higher in hypertrophic cardiomyopathy (HCMP) patients. The most common used implanted system was VVI-ICD (60.6%). **Conclusions:** The present study demonstrated that there was no significant difference between female and male patients in pacing mode selection, mostly VVI pacing mode was chosen; however, over a 10-year period pacemaker selection shifted from VVI to DDD pacemakers. Female patients had less ICD/CRT-D implantation than male patients.

KEYWORDS: Implantable cardioverter defibrillator, gender difference, pacemaker

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INTRODUCTION

Cardiac pacing, implantable cardioverter defibrillator (ICD), and cardiac resynchronization therapy and defibrillator (CRT-D) have become the standard therapy for symptomatic bradycardia, prevention of sudden cardiac death, and heart failure. The effect of gender differences in cardiology is being increasingly recognized. Recently, published studies demonstrated the relation between gender and cardiac device implantation indications and outcomes.^[1-4] We aimed to review the influence of gender-specific differences and patient demographics on cardiac device and pacing mode selection over a 10-year period.

METHODS

Patients who underwent cardiac device implantation for the first time, between January 1 2006 and June 31 2016, were reviewed. Data were retrieved from the clinic archive. The following parameters were evaluated as gender, age at pacemaker implantation, symptoms, indication, and pacing mode, and complications. The study protocol included all the first cardiac device

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implantations and replacement patients were excluded. The study was approved by local ethics committee.

STATISTICAL ANALYSIS

Test of significance between genders have been made using the χ^2 test for categorical variables and *t* test for continuous variables. Categorical data are given as percentages. Value of *P* less than 0.05 was considered as statistically significant. Data with inadequate number were not analyzed statistically; in this case, only the percentage of the subjects were given. Data were evaluated using SPSS 22.0 for Windows.

RESULTS

Seven hundred and four patients who underwent cardiac device implantation for the first time were included, 452 of these patients received pacemaker implantation and 252 of them received ICD/CRT-D implantation.

Pacemaker group

The mean age of female and male patients with pacemaker were 72.36 ± 11.1 versus 73.48 ± 11.4 , respectively (*P* = 0.31), and 49.9% of the patients were female. The most common indication was atrioventricular block (AVB) (84% for female and 85.2% for male). Female patients had more sick sinus syndrome (SSS) compared with male patients, but this

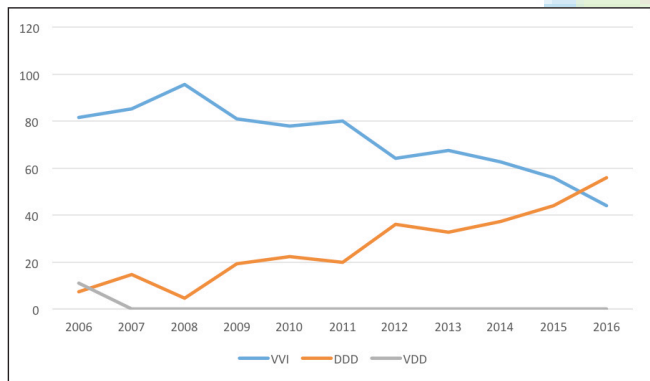


Figure 1: Trend of pacing mode at first implant according to years.

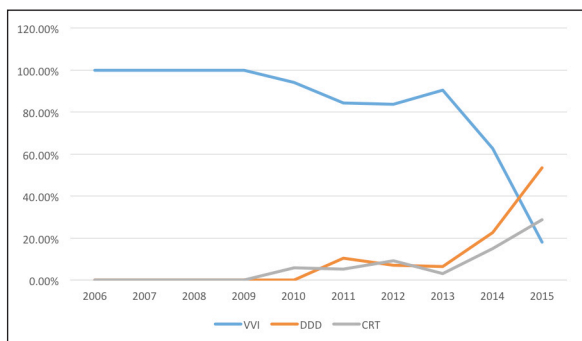


Figure 2: Trend of device types according to years

Table 1: Data of pacemaker implantation according to gender

	Female	Male	<i>P</i> value
<i>n</i> (%)	225 (49.9)	227 (50.1)	0.962
Age, years	72.36±11.1	73.48±11.4	0.310
Symptoms			0.025
Asymptomatic, (%)	3.1	4.0	
Syncope, (%)	46.7	50.0	
Presyncope, (%)	43.6	34.1	
Fatigue, (%)	5.8	6.2	
Dyspnoea, (%)	0.9	5.8	
Comorbidities			
HT, (%)	70.0	62.7	0.216
AF, (%)	11.6	12.7	0.794
DM, (%)	18.6	18.3	0.942
CKD, (%)	5.4	4.0	0.583
PCI, (%)	2.3	1.6	0.671
CABG, (%)	1.6	11.9	0.001
Ischemic heart disease, (%)	20.2	28.8	0.109
PAD, (%)	0.0	0.8	0.311
CVD, (%)	5.4	7.1	0.572
Hypothyroid, (%)	2.3	0.8	0.325
Indications			0.018
AVB, (%)	84.0	85.2	
SSS, (%)	11.2	4.9	
Slow rate AF, (%)	3.6	8.4	
Others, (%)	1.3	1.8	
Mode selections			
VVI, (%)	72.0	69.5	
DDD, (%)	27.6	29.6	
VDD, (%)	0.4	0.9	
Complications, %	9.3	10.1	0.568
Pneumothorax, %	1.5	3	
Pocket hematoma, %	2.0	2.0	
Mechanical complications, %	4.4	2.0	

AF = atrial fibrillation, AVB = atrioventricular block, CABG = coronary artery bypass graft, CKD = chronic kidney disease, CVD = cerebrovascular disease, DM = diabetes mellitus, HT = hypertension, PAD = peripheral arterial disease, PCI = percutaneous coronary intervention, MI = myocardial infarction, SSS = sick sinus syndrome.

Table 2: Rate of pacing mode at first implant according to years

	VVI	DDD	VDD	Total
2016	<i>n</i> (%) 11 (44,0)	14 (56,0)	0 (0,0)	25 (100,0)
2015	<i>n</i> (%) 33 (55,9)	26 (44,1)	0 (0,0)	59 (100,0)
2014	<i>n</i> (%) 42 (62,7)	25 (37,3)	0 (0,0)	67 (100,0)
2013	<i>n</i> (%) 29 (67,4)	14 (32,6)	0 (0,0)	43 (100,0)
2012	<i>n</i> (%) 25 (64,1)	14 (35,9)	0 (0,0)	39 (100,0)
2011	<i>n</i> (%) 28 (80,0)	7 (20,0)	0 (0,0)	35 (100,0)
2010	<i>n</i> (%) 42 (77,8)	12 (22,2)	0 (0,0)	54 (100,0)
2009	<i>n</i> (%) 38 (80,9)	9 (19,1)	0 (0,0)	47 (100,0)
2008	<i>n</i> (%) 21 (95,5)	1 (4,5)	0 (0,0)	22 (100,0)
2007	<i>n</i> (%) 29 (85,3)	5 (14,7)	0 (0,0)	34 (100,0)
2006	<i>n</i> (%) 22 (81,5)	2 (7,4)	3 (11,1)	27 (100,0)
Total	<i>n</i> (%) 320 (70,8)	129 (28,5)	3 (0,7)	452 (100,0)

Table 3: Data of pacemaker implantation according to patient age group

	<60	60-69	70-79	80-89	≥90
<i>n</i> (%)	44 (10,5)	72 (17,1)	187 (44,4)	111 (26,4)	7 (1,7)
Gender					
Female, <i>n</i> (%)	21 (10,0)	37(17,5)	105 (49,8)	47 (22,3)	1 (0,5)
Male, <i>n</i> (%)	23 (11,0)	35 (16,7)	82 (39,0)	64 (30,5)	6 (2,9)
Symptom					
Senkop, <i>n</i> (%)	21 (10,6)	36 (18,1)	80 (40,2)	58 (29,1)	4 (2,0)
Presenkop, <i>n</i> (%)	17 (10,4)	27 (16,5)	81 (49,4)	37 (22,6)	2 (1,2)
Fatigue, <i>n</i> (%)	1 (3,7)	3 (11,1)	15 (55,6)	7 (25,9)	1 (3,7)
Dispne, <i>n</i> (%)	2 (13,3)	3 (20,0)	4 (26,7)	6 (40,0)	0 (0,0)
Asymptom, <i>n</i> (%)	3 (18,8)	3 (18,8)	7 (43,8)	3 (18,8)	0 (0,0)
Etiology					
AV block , <i>n</i> (%)	34 (9,6)	57 (16,1)	155 (43,7)	103 (29,0)	6 (1,7)
SSS, <i>n</i> (%)	7 (21,2)	9 (27,3)	15 (45,5)	2 (6,1)	0 (0,0)
Slow Rate AF, <i>n</i> (%)	1 (3,8)	5 (19,2)	15 (57,7)	5 (19,2)	0 (0,0)
CSH <i>n</i> (%)	0 (0,0)	0 (0,0)	0 (0,0)	1 (100,0)	0 (0,0)
Cardioinhibitor, <i>n</i> (%)	2 (40,0)	1 (20,0)	1 (20,0)	0 (0,0)	1 (20,0)
Device					
VVI, <i>n</i> (%)	13(4,4)	33 (11,1)	139 (47,0)	104 (35,1)	7 (2,4)
DDD, <i>n</i> (%)	31 (25,0)	39 (31,5)	47 (37,9)	7 (5,6)	0 (0,0)
VDD, <i>n</i> (%)	0 (0,0)	0 (0,0)	1 (100,0)	0 (0,0)	0 (0,0)

AF = atrial fibrillation, AVB = atrioventricular block, CSH = carotid sinus hypersensitivity, SSS = sick sinus syndrome.

Table 4: Data of ICD/CRT-D implantation according to gender

	Female	Male	<i>P</i> value
<i>n</i> (%)	48 (19.0)	202 (81.0)	0.001
Age, years	62.5±10.8	61.0±11.5	0.390
Comorbidities, %			
HT, %	60.0	41.1	0.023
AF, %	24.4	19.7	0.478
DM, %	22.7	23.5	0.850
CKD, %	6.7	4.8	0.421
PCI, %	13.3	19.8	0.317
CABG, %	15.9	30.6	0.049
MI, %	13.3	23.0	0.154
PAD, %	0.0	2.1	0.419
CVD, %	4,4	2,1	0.330
Etiology, %			0,001
DCMP, %	24.2	75.8	
ICMP, %	13.3	86.7	
HCMP, %	53.8	46.2	
Mode selections, %			0.174
VVI,%	55.1	62.3	
DDD, %	22.4	25.6	
CRT,%	22.4	12.1	
Complications, %	9.3	10.1	0.568

AF = atrial fibrillation, CABG = coronary artery bypass graft, CKD = chronic kidney disease, CVD = cerebrovascular disease, DCMP = dilated cardiomyopathy, DM = diabetes mellitus, HCMP = hypertrophic cardiomyopathy, HT = hypertension, ICMP = ischemic cardiomyopathy, MI = myocardial infarction, PAD = peripheral arterial disease, PCI = percutaneous coronary intervention.

was not statistically significant [Table 1]. Main symptom for pacing was syncope (46.7% for female and 50% for male). The most frequently used pacing mode was VVI (70.8%) (72.0% for female and 69.5% for male), DDD pacing was used 28.5% of the patients (27.6% for female and 29.6% for male). VDD pacing ratio was 0.7% [Table 2]. Pacing modes have changed over the years. The initially high rates of VVI pacing modes have decreased and DDD pacing modes have progressively increased over the years [Figure 1] and [Table 2]. Table 3 showed the data of pacemaker implantation according to patient age group. VVI pacemakers were implanted with significant growing frequency, according to the older patients age [Table 3].

The highest rate of implanted pacemaker was ranging from 70 to 79 years of age. The gender distribution in different age decades was as follows for female versus male: <60 years: 10.0 versus 11.0%, 60–69 years: 17.5 vs 16.7%, 70–79 years: 49.8 vs 39.0%, 80–89 years: 22.3 vs 30.5%, >90 years: 0.5 vs 2.9% [Table 3]. Patients older than 80 years were 118 patients (25.9%), and 48 patients (40.6%) of these were women. There was no gender difference in occurrence of device-related complications (female 9.3% and male 10.1%, (*P* = 0.568 [Table 1]).

ICD/CRT group

Two hundred and fifty-two patients underwent ICD/CRT-D implantation for the first time, over the 10-

Table 5: Data of ICD/CRT-D implantation according to patient age groups

	<60	60-70	70-80	>80	Total
Gender					
Female, %	19.2	14.8	28.1	12.5	19.6
Male, %	80.8	85.2	71.9	87.5	80.4
Etiology					
DCMP, %	45.5	38.0	28.1	28.6	38.4
ICMP, %	45.5	57.0	66.7	71.4	55.0
HCMP, %	6.1	5.1	5.3	0.0	5.4
Other, %	3.0	0.0	0.0	0.0	1.2
Comorbidities					
HT, %	35.4	45.9	59.3	50	44.8
AF, %	14.6	24.0	25.9	25	20.6
DM, %	20.8	25.7	27.8	0.0	23.3
CKD, %	2.1	6.8	9.3	0.0	5.2
PCI, %	14.6	24.3	20.4	0.0	18.5
CABG, %	21.3	35.1	27.8	25	27.4
MI, %	20.8	16.2	29.6	12.5	21.1
PAD, %	2.1	1.4	0.0	12.5	1.7
CVD, %	2.1	2.7	3.7	0.0	2.6
NYHA					
Class I, %	19.2	13.0	14.0	0.0	15.4
Class II, %	68.7	67.5	63.2	100	67.9
Class III, %	12.1	19.5	22.8	0.0	16.7
Device					
VVI-ICD, %	57.6	57.5	64.9	100	60.7
DDD-ICD, %	30.3	23.8	21.1	0.0	25.0
CRT-D, %	12.1	18.8	14.0	0.0	14.3

AF = atrial fibrillation, CABG = coronary artery bypass graft, CKD = chronic kidney disease, CVD = cerebrovascular disease, DCMP = dilated cardiomyopathy, DM = diabetes mellitus, HCMP = hypertrophic cardiomyopathy, HT = hypertension, ICMP = ischemic cardiomyopathy, MI = myocardial infarction, PCI = percutaneous coronary intervention, PAD = peripheral arterial disease.

Table 6: Trend of device types according to years

Years	VVI	DDD	CRT	Total
2006	n (%) 3, (100,0)	0, (0,0)	0, (0,0)	3, (100,0)
2007	n (%) 5, (100,0)	0, (0,0)	0, (0,0)	5, (100,0)
2008	n (%) 2, (100,0)	0, (0,0)	0, (0,0)	2, (100,0)
2009	n (%) 2, (100,0)	0, (0,0)	0, (0,0)	2, (100,0)
2010	n (%) 16, (94,1)	0, (0,0)	1, (5,9)	17, (100,0)
2011	n (%) 16, (84,2)	2, (10,5)	1, (5,3)	19, (100,0)
2012	n (%) 36, (83,7)	3, (7,0)	4, (9,3)	43, (100,0)
2013	n (%) 28, (90,3)	2, (6,5)	1, (3,2)	31, (100,0)
2014	n (%) 25, (62,5)	9, (22,5)	6, (15,0)	40, (100,0)
2015	n (%) 10, (17,9)	30, (53,6)	16, (28,6)	56, (100,0)
2016	n, (%) 9, (27,3)	18, (54,5)	6, (18,2)	33, (100,0)

year period. Female patients were less than the male patients, 19.0% of the patients were female with mean age 62.5±10.8 and 81.0% of the patients were male with mean age 61.0±11.5 ($P = 0.39$). Female patients were older than the male patients at the time of implantation but this was not statistically significant [Table 4].

Indications for ICD and CRT-D implantation were ischemic cardiomyopathy (ICMP) (55.0%), dilated cardiomyopathy (DCMP) (38.4%), hypertrophic cardiomyopathy (HCMP) (5.4%), and others (1.2%) [Table 5]. The rate of male patients was higher in patients who have received device therapy for DCMP or ICMP, whereas the rate of female patients was higher in HCMP patients [Table 4]. Patients with symptomatic heart failure were in NYHA stage II (67.9%) and stage III (16.7%) [Table 5].

Most of the patients (99 patients) were under the age of 60, 19.2% of these were female. The proportion of ICD/CRT-D decreased with increasing age being 12.5% for female patients above the age of 80 [Table 5].

The distribution of implanted systems was as follows 60.7% VVI-ICD, 25.0% DDD-ICD, and 14.3% CRT-D [Table 5]. Overall, DDD-ICD has increased, becoming more frequent than VVI-ICD for the last 2 years [Figure 2] and [Table 6]. CRT-D system implantation has been started since 2010 and the rate of implantation has increased until the present day.

There were no gender differences according to rate of complication in ICD/CRT-D group [Table 4]. Pocket hematoma was more common in female compared with male (7.0 vs 4.5%). Male patients had a higher rate of pneumothorax and mechanical complications when compared with female patients (respectively, 3.4 vs. 0.0% and 1.1 vs. 0.0%).

DISCUSSION

In this study, we examined all the patients in whom cardiac device (pacemaker and ICD/CRT-D) was implanted for the first time between January 1, 2006 and June 31, 2016.

Our data showed no significant differences in terms of number of patients and age between both genders in the pacemaker group. According to gender distribution in different age decades, female patients were more frequent in ages from 70 to 79 years (49.8%). Male patients were more common in other age decades. Such results are inconsistent with the data from a previous study. In the study by Nowak *et al.*,^[1] male patients were more common than female patients. The highest rate of pacemaker implantation was in patients ranging from 70 to 79 years of age (44.4%), and this is consistent with other studies.^[5,6] These studies showed that approximately 80% of pacemakers were inserted in aging >70 years. Previous studies showed that incidence of pacemaker usage were getting higher with increasing age.^[7-9]

Our data showed that AVB was the most frequent major indication for pacemaker implantation. As distinct from

our study, Veerareddy *et al.*^[10] demonstrated, that SSS was the most frequent indication. In our study, the female patients had more SSS, whereas the rate of AVB was similar between two genders. Nowak *et al.*^[11] also found that male patients had more AVB and fewer SSS as primary pacemaker indication compared with female patients. Bradshaw *et al.*^[7] also demonstrated that women were somewhat more likely to be diagnosed with SSS (16 vs 11%). Symptoms leading to pacing in female patients were similar to male patients. Syncope was the most frequent symptom as other studies.^[11,12]

DDD pacing mode is considered to be the ideal pacing mode for tachy-brady syndrome with intact atrioventricular conduction.^[13] In the present study, VVI pacing was the most frequent used mode. In contrast, Italian registry study showed that the use of VVI pacemaker was 26.9% and DDD pacemaker was 63.6%.^[14] Spanish registry showed that 20% of the patients with AVB or SSS were paced in VVI mode despite being in sinus rhythm.^[15] In the current study, patients received significantly more VVI devices, with increasing age. Our results are consistent with data from previous studies^[10,16,17] showing no gender differences regarding pacing mode selection. Roeters Van Lennep *et al.*^[17] found that mode selection was influenced by age but not by gender. They demonstrated that, with increasing age, less DDD pacing systems were implanted. First, choice of VVI pacing mode may be due to the evidence that, DDD pacing was not found superior to VVI pacing, in patients with bradycardia.^[18] Secondly, due to the greater prevalence of atrial fibrillation in older patients, and thirdly, shorter life expectancy and comorbidities can influence pacemaker mode selection.^[19]

In the pacemaker group, there was no gender difference in occurrence of device-related complications (female 9.3%, male 10.1%, $P = 0.568$). Female patients had higher rates for mechanical complications than male patients had (4.4 vs. 2.0%). Previously published study clearly showed that female gender is associated with an increased risk of acute complications during pacemaker implantation.^[1] Smaller body size and vessel diameter might be possible explanations for the increase in complications in female patients; furthermore, they may be at higher risk for perforation due to thinner right ventricle wall. However, previously published studies showed no correlation between gender and complications during pacemaker implantation.^[20,21]

In the current study, 252 patients underwent ICD/CRT-D implantations for the first time, over the 10-year period. Most of the patients (99 patients) were under the age of 60, 19.2% of these were female. Consistent with

Hernandez's study, in our study, female patients received less ICD/CRT-D when compared with male patients.^[3,22] Implantable cardioverter defibrillator implantation among female patients steadily increased over the years, but it is still significantly lower in female patients.^[23] Female patients were older than male patients at the time of implantation but this was not statistically significant.

One of the other discrepancies of the present study is that the most common indication of ICD/CRT-D implantation was ICMP (55.0%) in both genders whereas, Russo *et al.*^[2] demonstrated that DCMP was more frequent in female patients.

Amit *et al.*^[3] studied sex differences in ICD implantation indications with outcome and contrary to our results they had less VVI-ICD than DDD-ICD implantation. In the current study, the distribution of implanted systems was as follows: 60.6% VVI-ICD, 25.5% DDD-ICD, and 13.9% CRT-D. Recently published studies demonstrated that DDD-ICD showed no benefit in reducing the incidence of death or heart failure admission and in reducing the number of inappropriate shocks.^[24] However, in our center, DDD-ICD has increased, becoming more frequent than VVI-ICD for the last 2 years.

Pocket hematoma was more common in female patients with ICD/CRT-D implantation. Male patients had a higher rate of pneumothorax and mechanical complications when compared to female patients. Russo *et al.*^[2] studied gender and device-related complications after primary prevention ICD in clinical practice. They found that among older patients receiving ICD, female patients experience worse outcome than do male patients.

Study limitations

Our study presents typical limitations of its retrospective nature. The data were collected from the single center. So, these results could not adapt to other pacing centers.

CONCLUSIONS

Our study has shown that gender-specific differences influenced the cardiac device implantations, pacing modes, and patients' demographics over a 10-year period. The present study showed there were no gender differences in terms of symptoms, indications and pacing mode selection. Female patients received less ICD/CRT-D when compared with male patients. The most common indication for ICD/CRT-D was ICMP. The most implanted system was VVI-ICD and there was no difference between both genders.

In this article distinctiveness of pacing indications, pacing modes, and procedural complications in relation to gender differences is discussed.

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Conflicts of interest

The authors have no conflicts of interest

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