Received: 2 October 2018 | Accepted: 25 December 2018

DOI: 10.1002/joa3.12156

ORIGINAL ARTICLE

WILEY Journal of Arrhythmia Open Access

The effect on upper extremity functions of cardiac electronic device placement on the dominant hand side

Ersin Çağrı Şimşek MD[1] | Ece Uslu Güvendi MD[2] | Aylin Şimşek MD[3] | Uğur Kocabaş MD[4] | Eser Varış MD[4] | Doğaç Çağlar Gürbüz MD[4] | Ayhan Aşkin MD[2]

[1]Department of Cardiology, Tepecik Training and Research Hospital, University of Health Science, Izmir, Turkey

[2]Department of Physical Medicine and Rehabilitation, Faculty of Medicine, Katip Çelebi University, Izmir, Turkey

[3]Department of Public Health, Faculty of Medicine, Dokuz Eylül University, Izmir, Turkey

[4]Department of Cardiology, Atatürk Training and Research Hospital, Katip Çelebi University, Izmir, Turkey

Correspondence
Ersin Çagrı Şimşek, Department of Cardiology, Tepecik Training and Research Hospital, Izmir, Turkey.
Email: ercagsim@hotmail.com

Abstract

Background: Although cardiac implantable electronic device (CIED) implantation is considered to be minor surgery, almost 60% of the patients suffer from shoulder-related problems a short time after the procedure. The purpose of this study was to determine the possible effects of the preference of the dominant side for CIED implantation on the ipsilateral superior extremity functions.

Methods: The study included a total of 107 patients who had been living with a CIED for >6 months. Patients were separated into two groups according to the dominant hand and side of the CIED. The ipsilateral dominant-hand group comprised those with a CIED on the same side as the dominant hand and the contralateral dominant-hand group included patients with the CIED placed on the contralateral side to the dominant hand. Visual analogue scale (VAS) pain score, quick disability of the arm shoulder and hand questionnaire (QuickDASH) and maximum isometric grip strength tests were used to evaluate the upper extremity disabilities.

Results: No significant difference was determined between the groups in respect of VAS pain scores (P = 0.10), QuickDASH scores (P = 0.21), and limitations of the shoulder joint range of motion (P = 0.192). The maximum isometric grip strength was significantly different in the right hands between two groups (34 [16-95]-40 [24-85]) (P = 0.02).

Conclusion: The present study shows that the joint range of motion limitation, pain, and disability of the upper extremity were no different in the affected arm compared to the healthy contralateral side with respect to the placement of the CIED on the dominant or non-dominant side.

KEYWORDS

arrhythmia, cardiac implantable electronic device, dominant hand side, shoulder impairment, upper extremity disabilities

1 | INTRODUCTION

The number of cardiac implantable electronic device (CIED) implantations has increased over recent years owing to ageing of the general population and increasing knowledge about ventricular arrhythmias and risk stratification for sudden cardiac death. Implantable cardioverter-defibrillators (ICDs) have reduced sudden death in patients at risk of attributable ventricular arrhythmias. Pacemakers improve quality of life in patients with bradyarrhythmias and reduce mortality in at-risk patients.

Although CIED implantation is considered to be minor surgery, almost 10% of the patients experience at least one complication.[1] In addition to venous access, leads and generator related complications, shoulder problems are another important complication.[2] Most patients have some discomfort at the site of the incision, and some may have mild ecchymosis after the procedure. After the recovery of the pocket, chronic shoulder pain and disability is commonly seen in patients with ICD.[3]

Lead dislodgement happens most often in the first 24-48 hours following CIED implantation. As the localization of CIED is close to the pectoral muscles, lead movements involving the pectoralis major muscle might cause dislodgement.[4,5] Therefore, some physicians prefer to immobilize the arm following implantation or restrict the arm movements above the shoulder level for a few weeks after implantation.[6] However, 2 RCTs have shown that early mobilization is safe and feasible, and some physicians encourage a full range of movement on the affected arm.[7,8] Moreover, patients could self-restrict the arm movements and arm-related daily activities to a further degree or for a longer duration to avoid the risk of device malfunction or to decrease pain.[9] However, prolonged immobilization or restriction of the arm movements have been associated with the development of shoulder problems such as adhesive capsulitis.[10]

The implantation of ICD to the left pectoral is the conventional normal practice owing to lower defibrillation thresholds, but the right pectoral may be required for pathological reasons such as thrombosis and infection on the left side. There is no prominent advantage of left or right pectoral implantation for pacemakers except the VDD pacemaker.[11] Therefore, most devices are placed on the patient's non-dominant side. The site of placement of the pulse generator is extremely important in providing long-term comfort and complete mobility for the adjacent shoulder. When deciding on the implantation side for the device, special conditions should be considered, such as athlete involved in sports related to arm movements, workers who perform the majority of their jobs with the arm, and women with a history of mastectomy. Although there are studies that have assessed upper extremity dysfunctions of patients with CIED, shoulder-related problems and the relationship to the side of the device has not been studied in literature to date.[3,9] The aim of this study was to determine the possible effects of the preference of the dominant side for CIED implantation on the ipsilateral superior extremity functions.

2 | METHODS

This cross-sectional study was conducted on patients who had undergone a CIED procedure at least 6 months previously. Participants were selected randomly from the patients admitted to our cardiology department for regular follow-up visit between January and August 2015. Patients who were unable or reluctant to participate, and those with a history of shoulder pathologies which could restrict motion of upper extremity before CIED implantation were excluded from the study. In addition, patients with device implantation except for routine procedure such as subpectoral or intramuscular placement and venous cutdown technique were not enrolled in the study. Cardiac resynchronization therapy devices were also excluded in the study due to a large number of confounding factors such as long implantation time required, greater pocket volume and excess number of leads. The other exclusion criteria included prior shoulder injury or surgery, a history of hemiplegia, and CIED implantation within the last 6 months. All patients underwent a standard baseline evaluation according to the study protocol, including collection of clinical data such as age, gender, heart disease, NYHA class, drug therapy and clinical evaluation by a team composed of one cardiologist and one physical therapist specialist. A physical examination which included assessment of the upper extremity joint function was performed. The contralateral upper extremity was used as a control. The patients were separated into 2 groups according to the dominant hand and the CIED implantation side. The ipsilateral dominant-hand group (IDH) included patients with CIED implantation on the same side as the dominant hand and the contralateral dominant-hand group (CDH) included patients with CIED implantation on the contralateral side to the dominant hand. The shortest distance from the top of the battery to the clavicle and incision length of the CIED pocket were noted to evaluate whether the location of the device and pocket size caused shoulder impingement. Informed consent was obtained from all individual participants included in the study and ethical approval was obtained from the Local Ethics Committee. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

2.1 | Implantation technique

The routine implantation technique which was performed only by 2 trained implanting physicians in our institution was described as below. The implantation side of the device determines according to the joint decision of both patient and physician. Nevertheless the right side is the first option for single-lead VDD pacing and left-side is the first option for the ICD implantation. First, an approximately 5-6 cm incision is made in the infraclavicular region, slightly inferior and medial to the deltopectoral groove. The axillary or subclavian vein is the main access site of choice for venous puncture. A sheath is then will be positioned in the vein and the appropriate leads are advanced into the vein through the sheath. According to the implant

device requirements, the leads will then be placed in the appropriate chambers. A pocket is created in the prepectoral subfascial position for placement of the generator and proximal parts of leads. The generator is secured to the pectoral muscle with a loosely coupled non-absorbable suture to prevent migration of the generator. Finally, the opening of the pocket and the superficial skin layer are closed with absorbable sutures. After the procedure, the patients undergo a 12 hours bed rest with the suggestion of sling immobilization. Before discharge, all the patients received standard of care instructions which included no lifting objects heavier than 3 kg and avoidance of raising the ipsilateral elbow above the shoulder level for 4 weeks.

2.2 | Shoulder and upper extremity evaluation

The shoulder pain (rest pain- activity pain-pain disturbing sleep) or discomfort of patients was assessed using the visual analogue scale (VAS) pain score which is a continuous scale ranging from 0 to 100 mm.[12] Higher VAS scores indicate worse pain and less shoulder mobility. Upper extremity functions were evaluated with the Quick Disability of the Arm, Shoulder, and Hand (QuickDASH) questionnaire. The Quick DASH is a shortened version of DASH and consists of an 11-item self-reporting questionnaire designed to assess physical function and symptoms during certain activities in patients with musculoskeletal disorders of the upper limb.[13] Responses are given based on a 5-point scale, and each question is scored between 1 and 5. QuickDASH has been shown to be valid and reliable for the Turkish population.[14] Higher QuickDASH scores indicate worse shoulder function.

Both shoulders range of motions (ROM) were measured for flexion, abduction, and external-internal rotation in a neutral position using a stainless steel goniometer. Each subject was seated on a stool and the examiner measured the ROM in each direction using a goniometer Degrees of reduced ROM in the shoulder joint in the arm on the side of the CIEDs were compared with the contralateral side. Those with a lower angle than the ROM of contralateral shoulder were considered to be ROM limitations.

Hand function following CIED was assessed using a Jamar hydraulic hand dynamometer (Sammons Preston, Inc., Bolingbrook, IL, USA) with "kg" unit. The standard test positions of the American Physiotherapists Hand Association were used to measure grip strength. Participants performed 5-second maximal contractions and verbal encouragement was used to ensure maximal contractions. Both hands were tested because the non-device side hand grip was used as a control. The left hand was tested first, followed by the right hand. Maximum isometric grip strength measurements were repeated three times for each hand and the average of these three values was used in the analysis. To ensure sufficient recovery, at least 1 minute rest time was given between each contraction. All measurements were taken by the same physician. The Jamar dynamometer was held from the top and the bottom by the operator to ensure that the weight of the device itself did not affect the measurements.

2.3 | Statistical analyses

The a priori required sample size was calculated using the G Power program (G*Power version 3.1.9.2, Germany) based on the change in the pain score. The sample size was calculated using the combination of power (0.80), α (0.05), effect size (0.25), repetitive intermeasure correlation (0.5) and ε (1.0) in accordance with the study design (bi-directional [time and treatment] analysis of variance in repeated measures). The results showed that at least 46 patients (92 total) in each group should be included in the study in order to reject the hypothesis of indifference. Continuous data were expressed as mean ± SD and categorical data were expressed as number (n) and percentage (%). Conformity of the data to normal distribution was assessed using the Kolmogorov-Smirnov and Shapiro-Wilk tests. The Mann-Whitney *U* test and the chi-squared test were used for comparisons of the affected arm and the contralateral arm within a group and for comparisons between two groups. All statistical analyses were performed using SPSS vn 15 software. A value of $P < 0.05$ was considered statistically significant.

3 | RESULTS

Evaluation was made for a total of 107 patients who had been living with a CIED for 6 months or more. Of those, 50 patients had an ICD and 57 patients had a pacemaker device, and 27 (25.2%) patients had needed at least one replacement. Due to the fear of causing problems with the CIED system, ipsilateral upper extremity movement was over-restricted in 35 patients (32.7%) according to the physician instruction a week after the implantation procedure. Disability of the affected extremity was determined in 17 (15.8%) patients who had a limitation of shoulder ROM in at least in one direction. Peri-incisional paresthesia in the subclavicular region was determined in 30 patients (28%) and the sulcus sign was positive in 25 patients (23.3%).

The demographic data of the patients and CIED characteristics are presented in Table 1. The IDH group comprised 55 patients with the device on the same side as the dominant hand and the CDH group comprised 52 patients with the CIED placed on the side contralateral to the dominant hand. The mean time since the last device implantation was 36.8 ± 22 months for the IDH group and 25.8 ± 18 months for the CDH group. The prevalence of diabetes, a risk factor for adhesive capsulitis, was not significantly different between the groups. The right arm was the dominant arm for 50 patients (90.9%) in the IDH group and 46 patients (88.4%) in the CDH group. While the pacemaker was the dominant CIED type in the IDH group (83.7%), the ICD was dominant in the CDH group (78.8%). The CIED type or mode, the number of replacements, battery volume, battery-clavicle distance and incision length are presented in Table 1. After the patients are divided into two groups depending on the presence of disability of the upper extremity, the characteristics of patients with CIED are presented in Table 2. The CIED type was ICD for 9 (53%) and pacemaker for 8 (47%) patients in the group of shoulder disability. The mean weight of battery was 57.9 ± 28.3 g

TABLE 1 Characteristics of the patients and the cardiac implantable electronic devices

	Ipsilateral dominant-hand group (IDH), n = 55	Contralateral dominant-hand group (CDH), n = 52	*P*
Age (year)	70 ± 12	68 ± 12	0.063
Gender(M/F)	24/31 (43.6%/56.4%)	19/33 (36.5%/63.5%)	0.084
Body mass index	28.9 ± 5.12	27.3 ± 3.74	0.137
Smoke	15 (27.2%)	19 (36.5%)	0.058
Alcohol	9 (16.3%)	6 (11.5%)	0.626
Diabetes mellitus	13 (23.6%)	15 (28.8%)	0.655
NYHA class			
I-II	47 (85.5%)	40 (77%)	0.131
III-IV	8 (14.5%)	12 (23%)	
CIED type			
ICD	9 (16.3%)	41 (78.8%)	<0.001
Pacemaker	46 (83.7%)	11 (21.2%)	
CIED mode			
VVI	16 (29.0%)	30 (61.4%)	<0.001
VDD	14 (25.4%)	3 (4.5%)	
DDD	25 (45.6%)	19 (34.1%)	
Number of replacements			
None	40 (72.7%)	40 (76.9%)	0.146
1	12 (21.8%)	10 (19.2%)	
2<	3 (5.4%)	2 (3.9%)	
Dominant hand (R/L)	50/5 (90.9/9.1%)	46/6 (88.4/11.6%)	
Weight of battery (g)	27 (18-79)	79 (18-92)	<0.001
Battery volume (cc)	12.1 (8.5-42.0)	42 (8.5-42)	<0.001
Battery-clavicula distance (cm)	7.0 ± 2.2	6.9 ± 3.0	0.419
Incision length (cm)	4.7 ± 1.6	5.6 ± 1.4	0.002
Time duration since last implantation (months)	36.8 ± 22	25.8 ± 18	0.029
Prolonged immobilization after procedure	17 (30.9%)	17 (38.6%)	0.413
Postprocedure complications	5 (10.0%)	4 (9.1%)	
Lead complications (dislocation-extraction)	1 (1.8%)	2 (3.6%)	
Pocket hematoma	2 (3.6%)	1 (1.8%)	
Pocket infection	2 (3.6%)	1 (1.8%)	

NYHA, New York heart association; L, left; R, right; CIED, cardiac implantable electronic device; ICD, implantable cardioverter-defibrillators; VVI, ventricular pacing, ventricular sensing, inhibition; VDD, ventricular pacing, dual sensing, dual response to sensing; DDD, dual pacing, dual sensing, dual response to sensing.

for the patients with shoulder disability and 46.9 ± 26.3 g for patients with non-disability. The right side was the placement side of CIED for 7 (41.1%) and 51 (56.6%) patients of the disability and non-disability groups, respectively.

3.1 | Functional evaluation

There was no statistically significant difference between the 2 groups in any of the VAS scores (VAS-rest $P = 0.10$, VAS-activity $P = 0.55$, VAS-sleep $P = 0.95$). The median QuickDASH score was 4.5 (0-79.5) in the IDH group and 6.8 (0-90) in the CDH group with no significant difference between the two groups (Table 3) ($P = 0.21$). No significant difference was determined between the groups in respect of both active and passive shoulder ROM limitations in three planes ($P = 0.192$, $P = 0.910$). For the right hand, the median maximum isometric grip strength (GAS) was lower in the IDH group than in the CDH group (34 (16-95) kg, 40 (24-85) kg respectively) ($P = 0.02$). For the left hand, the median maximum isometric grip

TABLE 2 Characteristics of patients and cardiac implantable electronic devices after the patients are divided into two groups according to the presence of disability of the upper extremity

	Patients with disability of the affected extremity, n = 17	Patients without a disability of the affected extremity, n = 90
Age (year)	63.0 ± 11.8	63.9 ± 12.8
Gender(M/F)	5/12 (29.4/70.6)	35/55 (38.8/61.2)
Ejection fraction (%)	37.3 ± 15.9	45.0 ± 15.5
CIED type		
ICD	9 (53)	41 (45.5)
Pacemaker	8 (47)	49 (54.5)
Number of replacements		
None	14 (82.4)	66 (73.4)
1	2 (11.8)	20 (22.2)
2<	1 (5.8)	4 (4.4)
Side of CIED		
Right	7 (41.1)	51 (56.6)
Left	10 (59.9)	39 (43.4)
CIED mode		
VVI	10 (58.8)	40 (44.4)
VDD	0	14 (15.6)
DDD	7 (41.2)	36 (40)
Number of leads		
1	10 (58.8)	51 (56.7)
2	7 (41.2)	39 8 (43.3)
Weight of battery (g)	57.9 ± 28.3	46.9 ± 26.3
Battery volume (cc)	29.5 ± 15.2	23.9 ± 12.1
Battery-clavicula distance (cm)	2.75 ± 0.4	2.76 ± 0.4
Incision length (cm)	4.93 ± 1.3	5.19 ± 1.6
Time duration since last implantation (months)	28.8 ± 21.2	34.2 ± 24.3

CIED, cardiac implantable electronic device; ICD, implantable cardioverter-defibrillators; VVI, ventricular pacing, ventricular sensing, inhibition; VDD, ventricular pacing, dual sensing, dual response to sensing; DDD, dual pacing, dual sensing, dual response to sensing.

strength was not significantly different in the IDH group and the CDH group (32 [15-85] kg, 36 [15-115] kg respectively) ($P = 0.106$).

After exclusion of the left-hand dominant patients (5 patients in the IDH group and 8 patients in the CDH group) maximum isometric grip strength on the side of the CIED was re-analyzed in comparison with the contralateral hand. Thus, the new groups were composed of right-arm dominant patients with right-side CIED or left-side CIED (Table 4). No statistically significant difference was determined in the median maximum isometric grip strength of the left hands and the maximum isometric grip strength of the right hand was different between the two groups. In the right-side CIED group, the maximum isometric grip strength was not significantly different between the right and left hands (34 [12-95]-32 [12-85], $P = 0.056$). In the left-side CIED group, the maximum isometric grip strength was significantly different between the right and left hands (40 (22-85)-36 (15-115), $P = 0.030$).

Range of motion limitations for flexion and abduction were higher in the arm on the side of the CIED compared with the control arm on the other side. However, the differences in the ROM between in the arm on the side of the CIED and control arm were similar in both groups (Table 5).

4 | DISCUSSION

Left pectoral implantation is the standard for ICD device placement to secure a lower defibrillation threshold. It is necessary to insert the ICD devices on the right side if there is thrombosis, infection, or retained leads on the left side.[15]

However, it is not clear which side should be chosen for the placement of a pacemaker generator. Right-sided implantation is only favored in single-lead VDD pacing in terms of better atrial sensing function.[11] The results of the present study demonstrate that joint ROM limitation, pain, and disability of the upper extremity were not different in the affected arm compared with the contralateral arm according to the placement of the CIED on the dominant side or non-dominant side. To the best of our knowledge, there has been no

TABLE 3 Functional assessments of the shoulder joint in ipsilateral and contralateral dominant recipients of cardiac implantable electronic devices

	Ipsilateral dominant group (IDH), n = 55	Contralateral dominant group (CDH), n = 52	*P*
VAS score			
VAS-rest	0.384 ± 1.49	0.944 ± 1.72	0.100
VAS-activity	1.307 ± 2.45	1.444 ± 2.51	0.552
VAS-sleep	0.871 ± 2.16	0.972 ± 2.26	0.957
QuickDASH score	4.5 (0-79.5)	6.8 (0-90)	0.212
JAMAR score (kg)			
Right	34 (16-95)	40 (24-85)	0.02
Left	32 (15-85)	36 (15-115)	0.106
Sulcus sign	14 (25.4%)	11 (21.1%)	0.528
Peri-incisional paresthesia	17 (30.9%)	13 (25%)	0.565

VAS, Visual analogue scale; QuickDASH, quick disability of the arm shoulder and hand questionnaire.

TABLE 4 Comparison of maximum isometric grip strength of upper extremities between right and left-side CIEDs among the right-dominant recipients

	Right-side CIED, n = 50	*P*[a]	Left-side CIED, n = 44	*P*[b]	Between right-side and left-side recipients *P*
Jamar-right (kg)	34 (12-95)	0.056	40 (22-85)	0.030	0.044[c]
Jamar-left (kg)	32 (12-85)		36 (15-115)		0.166[d]

CIED, cardiac implantable electronic device.
[a]Indicates the difference between right and left hand in right-side CIEDs recipients.
[b]Indicates the difference between right and left hand in left-side CIEDs recipients.
[c]Indicates the difference in right hand between the right-side and left-side recipients.
[d]Indicates the difference in left hand between the right-side and left-side recipients.

previous study that has examined upper extremity function related to the dominant or non-dominant side in patients with CIED.

An overlooked complication of device implantation is shoulder pain and disability after the implantation procedure. Shoulder problems occur for various reasons in the first months after implantation: (a) a slower physiological recovery caused by a lower degree of physical activity in ICD carriers, (b) self-restriction from fear of causing problems with the CIED system, and (c) an implantation technique which requires a submuscular pocket. However, the persistence of shoulder impairment that is related to shoulder motion in the long term may be explained by the direct effect of the device on the shoulder, because patients get used to the device with time and the recovery process will be completed with daily activities even without a special exercise regime. Shoulder impairment in patients with CIED could be attributed to muscle weakness, muscular imbalance of the ipsilateral shoulder girdle and adhesive capsulitis because of prolonged immobilization, or restriction of shoulder movements.[10] Korte et al followed 50 patients with ICD and reported shoulder-related problems in at least 60% of the patients 3 months after the procedure.[16]

Diemberger et al reported that 60% to >75% of ICD implantation patients suffered shoulder impairment in the first 2 weeks who tended to recover within 3 months in the vast majority of subjects.[17] Limitation in shoulder ROM is one of the important components of shoulder impairment. Korte et al reported that 8% of the patients had restricted shoulder ROM at different degrees at 12 months after the procedure.[16] Diemberger et al showed that 28% of the ICD patients had ROM limitation at 3 months after the procedure.[17] Of the total 107 patients in the current study, 17 (15.8%) had limitation of shoulder ROM. Although the designs of previous studies were different, the percentage of patients in the current study with ROM limitation in the long term of CIED use was similar to that of the previous studies. Loss of ROM in abduction and flexion in the affected shoulder was higher in both IDH and CDH groups. The close association of the device with the pectoralis major muscle might have caused limitation of flexion, and stretching of the device or the muscle fibers could be related to limitation of abduction.[9]

Pain in the implantation site due to the placement procedure is common and can be treated with analgesics. Pain may also be related to activities. In a study by Daniels et al, shoulder pain was assessed after implantation and in the control group the mean VAS score was <1.0 at the 6 month follow-up examination.[18] In the current study, pain was assessed using VAS at rest, activity and sleep. The mean VAS-rest, VAS-activity, and VAS-sleep scores were low and these data were comparable with the above-mentioned study. However, it must be emphasized that pain in the affected-side shoulder is not a common complication in the long term especially after 6 months. Moreover, there was no significant difference between

TABLE 5 Degrees of reduced range of motion in the shoulder joint in the arm on the side of the cardiac implantable electronic devices compared with contralateral side.

	Ipsilateral dominant group (IDH), n = 55				Contralateral dominant group (CDH), n = 52			
	Δ degrees 1-10	Δ degrees 11 -20	Δ degrees 21-30	Δ degrees ≥-31	Δ degrees 1-10	Δ degrees 11 -20	Δ degrees 21-30	Δ degrees ≥-31
Flexion	1 (2%)	2 (4%)	0	2 (4%)	2 (4%)	1 (2%)	0	3 (6%)
Extension	1 (2%)	0	0	0	1 (2%)	0	0	0
Abduction	2 (4%)	1 (2%)	0	2 (4%)	1 (2%)	1 (2%)	2 (4%)	3 (6%)
Adduction	0	0	0	0	0	0	0	0
Internal rotation	1 (2%)	0	0	1 (2%)	1 (2%)	1 (2%)	0	1 (2%)
External rotation	0	1 (2%)	0	1 (2%)	1 (2%)	1 (2%)	0	1 (2%)

Δ; difference of range of motion between the arms.

the dominant-side CIED and the non-dominant CIED groups in respect of the VAS pain scores. QuickDASH is a patient-reported outcome measure designed to measure symptoms and physical function in patients with disorders of the upper extremity.[19] It covers three different concepts: disability/symptoms, work, and sports/performing arts. In the current study, the QuickDASH findings indicated that the disorders of the upper limb in patients with CIED were not significantly different between the dominant-side CIED and the non-dominant CIED groups. Previous studies in literature have shown that shoulder functional assessment scores are higher in the early period and decrease over time.[16,18] The results of the QuickDASH in the current study were also consistent with literature. Furthermore, the VAS and QuickDASH scores indicated very low degrees of shoulder disabilities in patients with CIEDs after 6 months independently of placement on the dominant side.

Measurement of grip strength is commonly used within rehabilitation to compare against normative values or to compare strength between dominant and non-dominant limbs. A stable proximal shoulder girdle is essential to enable optimal recruitment of the distal muscles, and the force transmitted along the myofascial pathways.[20] Grip strength has also been shown to be correlated with the strength of the upper extremity (hand, shoulder, and elbow joint) as an objective measure of upper extremity function.[21,22] A review of 10 studies found that right-side dominant subjects were stronger with their right hand, whereas in the left-side dominant subjects the results were equivocal.[23] Nevertheless, Peters et al found no significant difference in GAS between the dominant and non-dominant hand.[24] In the current study, the maximum isometric grip strength was found to be significantly lower in the left hand compared with the right hand in the right-side dominant patients with CIED on the left side. Moreover, the maximum isometric grip strength was not found to be significantly different between the left and right hands in the right-side dominant patients with CIED on the right side. The differences may be explained by muscle weakness and imbalance in the rotator cuff and scapula, with earlier recovery of the dominant arm more likely since patients tend to use the dominant arm earlier in daily activities rather than the non-dominant arm. Also, it could be related to device size as there is a preponderance of ICDs in the contralateral implants.

Although the study population size can represent a limitation, it should be underlined that this is the first study in this field. Another limitation is that evaluation was made of patients fitted with different cardiac devices such as ICD and pacemaker and patients required the devices for different clinic reasons. Also, ICD tends to be implanted on the left side because of the defibrillation threshold. Nevertheless, the aim of the current study was to explore whether the local effect of any device in the infraclavicular region affects the ipsilateral shoulder functions. Even if the batteries of different devices are of different sizes, we think these were very small differences which could not affect the upper extremity function. Further studies are required to investigate the possible effect of different device type one by one on shoulder function.

5 | CONCLUSIONS

The results of this study indicate that CIED placement on the dominant side has no effect in terms of pain, ROM and disability in the involved upper extremity. In addition, placing the CIED on the non-dominant side or dominant side was seen to have no effect on the daily activities of the shoulder, arm and the hand in the long term. Nevertheless, handgrip strength was found to be different in patients with CIED placement on the non-dominant side compared with the dominant side. There is a need for further extensive, randomized, controlled studies to confirm these findings.

CONFLICT OF INTEREST

Authors declare no conflict of interests for this article.

ORCID

Ersin Çağrı Şimşek https://orcid.org/0000-0001-6084-0982
Ayhan Aşkin https://orcid.org/0000-0001-9445-4430

REFERENCES

1. Kirkfeldt RE, Johansen JB, Nohr EA, Jørgensen OD, Nielsen JC. Complications after cardiac implantable electronic device implantations: an analysis of a complete, nationwide cohort in Denmark. Eur Heart J. 2014;35:1186–94.
2. Lee DS, Krahn AD, Healey JS, et al. Evaluation of early complications related to de novo cardioverter defibrillator implantation insights from the Ontario ICD database. J Am Coll Cardiol. 2010;55:774–82.
3. Celikyurt U, Agacdiken A, Bozyel S, et al. Assessment of shoulder pain and shoulder disability in patients with implantable cardioverter-defibrillator. J Interv Card Electrophysiol Int J Arrhythm Pacing. 2013;36:91–4.
4. Tokano T, Nakazato Y, Sasaki A, et al. Dislodgment of an atrial screw-in pacing lead 10 years after implantation. Pacing Clin Electrophysiol. 2004;27:264–5.
5. Lal RB, Avery RD. Aggressive pacemaker Twiddler's syndrome. Dislodgement of an active fixation ventricular pacing electrode. Chest. 1990;97:756–7.
6. Wood MA, Ellenbogen KA. Cardiology patient pages. Cardiac pacemakers from the patient's perspective. Circulation. 2002;105:2136–8.
7. Naffe A, Iype M, Easo M, et al. Appropriateness of sling immobilization to prevent lead displacement after pacemaker/implantable cardioverter-defibrillator implantation. Proc Bayl Univ Med Cent. 2009;22:3–6.
8. Miracapillo G, Costoli A, Addonisio L, et al. Early mobilization after pacemaker implantation. J Cardiovasc Med. 2006;7:197–202.
9. Findikoglu G, Yildiz BS, Sanlialp M, et al. Limitation of motion and shoulder disabilities in patients with cardiac implantable electronic devices. Int J Rehabil Res. 2015;38:287–93.
10. Struyf F, Meeus M. Current evidence on physical therapy in patients with adhesive capsulitis: what are we missing? Clin Rheumatol. 2014;33:593–600.
11. Haghjoo M, Arya A, Emkanjoo Z, Sadr-Ameli MA. Optimal side of implant for single-lead VDD pacing: right-sided versus left-sided implantation. Pacing Clin Electrophysiol. 2005;28:384–90.
12. McCormack HM, Horne DJ, Sheather S. Clinical applications of visual analogue scales: a critical review. Psychol Med. 1988;18:1007–19.
13. Beaton DE, Wright JG, Katz JN; Upper Extremity Collaborative Group. Development of the QuickDASH: comparison of three item-reduction approaches. J Bone Joint Surg Am. 2005;87:1038–46.
14. Koldas Dogan S, Ay S, Evcik D, Baser O. Adaptation of Turkish version of the questionnaire Quick Disability of the Arm, Shoulder, and Hand (Quick DASH) in patients with carpal tunnel syndrome. Clin Rheumatol. 2011;30:185–91.
15. Kiuchi MG, Chen S, Paz LMR, Pürerfellner H. Effectiveness evaluation of ICDs implanted in the right side vs. left side. Int Cardiovasc Forum J. 2017;11:65–8. https://doi.org/10.17987/icfj.v11i0.443.
16. Korte T, Jung W, Schlippert U, et al. Prospective evaluation of shoulder-related problems in patients with pectoral cardioverter-defibrillator implantation. Am Heart J. 1998;135:577–83.
17. Diemberger I, Pegreffi F, Mazzotti A, et al. Implantation of cardioverter-defibrillator: effects on shoulder function. Int J Cardiol. 2013;168:294–9.
18. Daniels JD, Sun S, Zafereo J, et al. Preventing shoulder pain after cardiac rhythm management device implantation: a randomized, controlled study. Pacing Clin Electrophysiol. 2011;34:672–8.
19. Kennedy CA, Beaton DE, Solway S, McConnell S, Bombardier C. Disabilities of the arm, shoulder and hand (DASH). DASH QuickDASH Outcome Meas User's Man Third Ed Tor Ont Inst Work Health. 2011.
20. Huijing PA, Baan GC. Myofascial force transmission: muscle relative position and length determine agonist and synergist muscle force. J Appl Physiol (1985). 2003;94:1092–107.
21. Bohannon RW. Hand-grip dynamometry provides a valid indication of upper extremity strength impairment in home care patients. J Hand Ther. 1998;11:258–60.
22. Balogun JA, Akomolafe CT, Amusa LO. Grip strength: effects of testing posture and elbow position. Arch Phys Med Rehabil. 1991;72:280–3.
23. Bohannon RW. Grip strength: a summary of studies comparing dominant and nondominant limb measurements. Percept Mot Skills. 2003;96:728–30.
24. Peters MJH, van Nes SI, Vanhoutte EK, et al. Revised normative values for grip strength with the Jamar dynamometer. J Peripher Nerv Syst. 2011;16:47–50.

How to cite this article: Şimşek EÇ, Uslu Güvendi E, Şimşek A, et al. The effect on upper extremity functions of cardiac electronic device placement on the dominant hand side. *J Arrhythmia*. 2019;35:279–286. https://doi.org/10.1002/joa3.12156