Original paper

Long-term results of conservative treatment of pacemaker pocket site infections

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Abstract

Introduction: The increasing frequency of cardiac device use has led to an increase in complication rates. The standard treatment for cardiac device-related infections is removal of the entire pacemaker system and reimplantation from the contralateral side after systemic antibiotherapy. The efficacy of various conservative treatments has been established for many years, but there is conflicting information in the literature regarding long-term efficacy.

Aim: Our study investigated the long-term efficacy of conservative treatment in patients with pacemaker pocket site infection.

Material and methods: In this retrospective study, according to the exclusion criteria, 132 patients were included. Patients were divided into conservative and standard treatment groups. Conservative treatment was considered to be opening the pacemaker pocket capsule, removing all infected and necrotic tissue, cleaning the capsule, and embedding the battery in the prepectoral region in the subpectoral muscle region.

Results: The follow-up time was 36 ±12.96 months in the conservative treatment group and 39.6 ±10.8 months in the standard treatment group. During this period, no re-infection at the pacemaker pocket site was observed in either group. Examination of the swab cultures of the patients' pacemaker wounds revealed negative culture results in 15 patients (15 out of 60) in the conservative treatment group. In the standard treatment group, 60 patients (60 out of 72) were culture-negative. This difference was statistically significant (p = 0.04).

Conclusions: After a rigorous evaluation, conservative treatment is considered effective and safe in the long term in patients with device pocket site infection.

Key words: conservative treatment, long term results, pacemaker pocket infections.

Summary

The increasing frequency of cardiac device use has led to an increase in complication rates. The standard treatment for cardiac device-related infections is removal of the entire pacemaker system and reimplantation from the contralateral side after systemic antibiotherapy. Although the primary treatment method is removal of the entire system, it is complex and associated with significant complications and costs. Conservative treatment consists essentially of limited debridement of the necrotic and infected tissue, irrigation of the pocket site, and reinsertion of the battery into the cleansed area with appropriate systemic antibiotic therapy. There are few studies on the long-term efficacy of conservative treatment. Although removal of the entire system is accepted as the basic treatment for cardiac device pocket site infections, after a very rigorous evaluation, conservative treatment is considered effective and safe in the long term in patients with no evidence of systemic infection, intra-pocket abscess or fistula, vegetations on leads or valves and no previous history of battery replacement. We think this study will shed light on future studies.

Introduction

Permanent cardiac pacemakers and implantable devices have been increasingly used to treat cardiac diseases in recent years. The increasing frequency of cardiac device use has led to an increased rate of complications [1, 2]. The most common of these complications is cardiac device pocket site infection [3, 4]. The infection may be confined to the pocket or associated with the lead

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or endocarditis. Pacemaker pocket site infections are observed with a frequency between 1% and 12.5%, leading to a significant increase in morbidity and mortality [5, 6].

The standard treatment for cardiac pacemaker-related infections is removal of the entire pacemaker system and reimplantation on the contralateral side after systemic antibiotherapy. Although the primary treatment method is removal of the entire system, this is a complex intervention and associated with significant complications and costs [6, 7]. Conservative treatment consists essentially of limited debridement of the necrotic and infected tissue, irrigation of the pocket site, and reinsertion of the battery into the cleansed area with appropriate systemic antibiotic therapy. Removal of the entire system in the early phase, when detected in cardiac device-related infections, has been found to decrease mortality; otherwise, mortality increases significantly [8]. In the study by Le *et al.*, delayed removal of the entire system was observed to increase mortality threefold at the end of the one-year follow-up period [9].

Aim

Our study investigated the long-term efficacy of conservative treatment in patients with pacemaker pocket site infection.

Material and methods

After ethics committee approval, this study retrospectively included patients with cardiac device pocket site infection in a single center. A total of 132 patients were included in the study between 2016 and 2021. The study was approved by the local ethics committee (Non-Interventional Clinical Research Ethics Committee permission dated 14/01/2021 and numbered 2021/05) and conducted in accordance with the Declaration of Helsinki.

Pocket infection is defined as an infection limited to the generator pocket and can present with redness, swelling, and pain due to the skin erosion with exposure of the generator and/or leads.

After cautious and comprehensive examination, all patients were given information about the treatment modality. It was stated that the extraction procedure is the ideal treatment method for those who did not accept this treatment. Enough information was given to the patients about conservative treatment and uncertain long-term results after a consent form was obtained.

Exclusion criteria for the study were a previous history of pacemaker battery replacement, presence of symptoms and evidence of systemic infection, growth in blood cultures, fever of at least 39 degrees, intra-pocket abscess and fistula by pocket site ultrasonography and vegetations on leads and valves by echocardiography and PET (positive emission tomography).

The demographic, echocardiographic and pacemaker characteristics of all patients included in the study were recorded. Patients were screened for age, gender, diabetes mellitus and chronic renal failure. Diabetes mellitus was defined as taking an antidiabetic drug or having at least 2 fasting blood glucose measurements above 126 mg/dl. Chronic renal failure was defined as a glomerular filtration rate of less than 60 for more than 3 months. A diagnosis of hypertension was accepted if the patient was taking antihypertensive therapy or had at least 3 measurements above the systolic value of 160 mm Hg and the diastolic value of 90 mm Hg. The presence of more than 50% lesions on coronary angiography was accepted for the diagnosis of coronary artery disease. Echocardiographic examination was performed with the iE33 cardiac ultrasound system (Phillips Healthcare, Best, The Netherlands) and a 2.5–5-MHz probe system, and ejection fraction was measured by the modified Simpson method.

The patients' existing pacemaker models were determined and recorded as VVI (single-chamber), DDD (dual-chamber), and cardiac resynchronization therapy (CRT). In addition to pacemaker characteristics of all patients, whole blood values, renal function and serology were recorded. Wound swab cultures were obtained and recorded in all patients.

Surgical procedure

All patients who developed cardiac device pocket site infection were initially given systemic anti-staphylococcal antibiotics for 1 week. Then the cases were divided into two groups according to the treatment modality: standard treatment and conservative treatment. While standard treatment included disassembly of the entire device system, administration of systemic antibiotics, and reimplantation from the opposite side, conservative treatment was considered to be opening the pacemaker pocket capsule under local anesthesia, if necessary under general anesthesia, removing all infected and necrotic tissue, cleaning the capsule, and embedding the battery in the prepectoral region in the subpectoral muscle region after rifampicin and saline irrigation of the wound. All patients received systemic antibiotics for 1 month after surgery.

Follow-up of patients

The wound site was examined before discharge from the hospital. Thereafter, all patients were examined at 6-month intervals under hospital conditions and their battery measures were reviewed. Patients were informed about wound infections. Each patient's interval, hematologic and serologic values were checked, and pocket site ultrasonography and echocardiography were done. Follow-up periods of the patients were recorded.

Statistical analysis

SPSS 25 (IBM Corp. Released 2017. IBM SPSS Statistics for Windows, version 25.0. Armonk, NY: IBM Corp.),

a statistical package program, was used to analyze the data. Variables were expressed by mean ± standard deviation, percentage and frequency values and analyzed after controlling for normality and homogeneity of variance (Shapiro-Wilk and Levene test). In data analysis, the independent 2-group *t*-test (Student's *t*-test) was used to compare two groups, and the Mann-Whitney *U* test was used when conditions were not met. $P < 0.05$ was accepted as the significance level for the tests.

Results

A total of 132 patients were enrolled in the study, of whom 60 were treated with conservative treatment and 72 with standard treatment. None of the patients who were followed up died. No re-infection at the pacemaker pocket site was observed in either group. The mean follow-up time of patients was 36 ±12.96 months in the conservative treatment group and 39.6 ±10.8 months in the standard treatment group.

While the mean age of patients in the conservative treatment group was 72.6 ±10.1 years, it was 66.4 ±10.4 years in the standard treatment group. In the standard treatment group, 48 patients were male and 24 were female. In the conservative treatment group, 48 patients were male and 12 were female. There was no difference between the groups in age and gender ($p > 0.05$).

No significant difference was found when comparing the patients in the two groups in terms of age, gender, ejection fraction, pacemaker models, antibiotics received, diabetes mellitus, hypertension and coronary artery disease. When the swab cultures of the patients' pacemaker wounds were examined, the culture was negative in 15 patients (15 out of 60) in the conservative treatment group. In the standard treatment group, 60 patients (60 out of 72) were culture-negative. This difference between the two groups was statistically significant ($p = 0.041$) (Table I). There was no statistically significant difference in hematological, renal and serological functions between the groups ($p > 0.05$) (Table II).

Table I. Comparison of demographic, pacemaker and wound characteristics of the two groups

Parameter			Treatment modality		*P*-value
			Conservative treatment group ($n = 60$)	Standard treatment group ($n = 72$)	
Age			72.6 ±10.11	66.42 ±10.43	0.18
Gender	Male	*n*	48	48	0.48
	Female	*n*	12	24	
Ejection fraction	< 30	*n*	54	60	0.46
	30–45	*n*	6	0	
	> 45	*n*	0	12	
Diabetes mellitus	Absent	*n*	30	42	0.67
	Present	*n*	30	30	
Hypertension	Absent	*n*	18	48	0.08
	Present	*n*	42	24	
Chronic renal failure	Absent	*n*	30	48	0.43
	Present	*n*	30	24	
Coronary artery disease	Absent	*n*	42	42	0.68
	Present	*n*	18	30	
Antibiotic treatment	Ampicillin/sulbactam	*n*	30	30	0.34
	Ciprofloxacin	*n*	6	0	
	Cefazolin	*n*	12	12	
	Ceftriaxone	*n*	0	6	
	Vancomycin	*n*	0	12	
	Piperacillin tazobactam		12	12	
Pacemaker type	VVI	*n*	36	54	0.13
	DDD	*n*	0	12	
	CRT	*n*	24	6	
Growing pathogen	Staph aureus	*n*	21	6	0.04
	Enterococci	*n*	12	3	
	Other pathogens	*n*	12	3	
	Culture negative	*n*	15	60	

VVI – single chamber, DDD – dual chamber, CRT – cardiac resynchronization therapy.

Table II. Basic laboratory parameters of the patients

Parameter	Conservative treatment group *N* = 60	Standard treatment group *N* = 72	*P*-value
CRP	42.5 ±43.68	71.33 ±51.05	0.17
Sedimentation	41.1 ±26.78	53.17 ±33.17	0.37
Hemogram	11.61 ±1.97	19.75 ±30.16	0.41
Leukocytes	8330 ±3117.71	7950.83 ±2248.09	0.74
Platelets	198700 ±55699.69	227333.33 ±66751.01	0.29
Urea	41 (37.00–45.00)	40.0 (32.00–45.00)	0.67
Creatinine	1.0 (0.90–1.16)	1.0 (0.89–1.20)	0.79
K	4.3 (4.10–4.60)	4.3 (4.10–4.60)	0.42
Na	140.0 (136.00–141.00)	140.0 (136.00–141.50)	0.71

CRP – C reactive protein.

Discussion

The long-term effectiveness of conservative treatment in pacemaker pocket site infection was examined in our study. The first significant result of the present study is that conservative treatment is considered effective and safe. The secondary result is that the swab culture of the pacemaker pocket site is not important for treatment choice.

In meta-analyses and real-life studies, removal of the entire system is recommended as standard treatment because the infection may not only progress in the pocket but also cause endocarditis via the lead [10, 11]. In the study of cardiac device infection conducted by Gomes *et al.*, the lead was removed in 348 patients. At the end of the study, 65.2% of patients were found to have growth on the pocket site or in the lead culture. Growth of microorganisms was observed only in the lead cultures of 18.8% of patients [12]. However, various conservative treatment options for pacemaker pocket site infections have been available for many years [13, 14]. In the case series of Lopez with 5 patients who received closed irrigation after all nonviable tissue, chronically inflamed tissue, granulation tissue, and scar tissue were debrided and all foreign bodies were removed, no recurrence was observed at the 1-year follow-up [15]. Case reports and a two-center study of cardiac device-related infections by Lewkowiez *et al.* showed that after debridement of all infected and necrotic tissues, closed irrigation with povidone-iodine solution for 2–7 days was successful in the long term and could be used as an alternative to device extraction [16, 17].

When the groups were compared in our study, the essential difference between the groups was in the results of the pacemaker wound swab culture. Statistically significant culture positivity was found in the conservative treatment group. Several studies have shown that swab cultures are negative in 12–21% of cases, even when purulent discharge from the pacemaker pocket site is present [18, 19]. Recently published results of a long-term study showed that swab cultures were found negative in 39.9% of patients with pacemaker pocket site infection [20]. A total of 26 patients were included in the study conducted on pacemaker pocket site infection by Zheng *et al.*; wound swab culture was positive in half of the patients. After conservative treatment, patients were followed up for a mean of 26.92 ±9.4 months. No recurrent infection was observed in 23 of the patients during the follow-up period [21]. In the study performed by Kim *et al.* on 5 patients, a myocutaneous latissimus dorsi flap was used in patients who had a pacemaker-positive local wound culture. No recurrence was observed at the end of the study. It was also concluded that the wound culture result did not affect treatment [22]. In a study by Bisignani *et al.* of 25 cases in the elderly, no systemic infection or blood culture positivity was observed, but 24 of 25 patients had pacemaker pocket site infection with positive culture results. Re-infection was observed in only 1 patient [23]. According to the 2020 European Cardiac Rhythm Consensus Document, cardiac device infection was accepted if the site of infection was a pacemaker generator or lead protrusion, regardless of the results of the swab cultures [1–4]. In addition, according to the 2019 International Diagnostic Criteria for Implantable Cardiac Device Infections, pacemaker site involvement and positive blood culture were accepted as minor criteria [4].

In our study, the pacemaker batteries were removed from the prepectoral region and relocated to the subpectoral muscle region. Previous studies have shown that placement of a pacemaker battery in the intrapectoral and subpectoral regions requires greater dissection and therefore more vessels and nerves are damaged [24], which is associated with an increased risk of postoperative hematoma. Hematomas in the pocket site have been shown to directly increase the risk of pacemaker-related infection [25]. However, in a study by Al-banainah *et al.* of 16 patients with pocket site infection in the prepectoral region, the batteries were transferred to the subpectoral region, and no serious complications or recurrences were observed. As a result of the study, it was hypothesized

Table III. Major contemporary studies with trials of conservative treatment

Studies	Treatment modality	Number of patients	Follow-up	Outcomes
Pollar *et al.*	Vacuum-assisted closure (V.A.C.) treatment	5	34.6 ±19.2 months	One patient with reinfection
Satsu *et al.*	Vacuum-assisted wound closure (V.A.C) treatment	4	5–15 months (mean 9.3 months)	No reinfection
Mcgarry *et al.*	Vacuum-assisted wound closure (V.A.C) treatment	28	49 (10–752) days	One patient with reinfection
Zhang *et al.*	Vacuum-assisted wound closure (V.A.C) treatment	26		3 patients with reinfection
Bisigani *et al.*	Local revision, debridement, and reimplantation	25	24 (14–34) months	One patient with reinfection
Cassagneau *et al.*	Local revision, debridement, and reimplantation	Total: 33 patients Group 1: 9 patients Scar Abnormalities Group2: 8 patients Mechanical Protrusion Group 3: 16 patients "Inflammatory Extrusion	37 ±12 months	Group 1: 5 patients with reinfection Group 2: no patient developed local or systemic infectious manifestations Group 3: 10 patients with reinfection
Kim *et al.*	Local revision, debridement, reconstruct partial LD myocutaneous flap	5	12 to 60 months	No reinfection

that the battery in the subpectoral region creates a new and sterile environment for the battery [26].

There are few studies on the long-term efficacy of conservative treatment. Poller *et al*., Satsu *et al*., McGarry *et al*., and Zheng *et al.* have stated that the negative pressure drainage system is effective for pacemaker pocket site infections in the long term [21, 27–29]. In a study of 25 case series by Bisignani *et al.* no recurrence was observed in 24 of the patients during the 24-month follow-up period after local revision, debridement, and reimplantation [23]. A total of 33 patients were included in the study by Cassagneau *et al.* The patients were divided into three groups according to the clinical characteristics of the pocket site. In the third group of the study, 16 patients had evidence of impending extrusion of the pulse generator associated with signs of local cutaneous inflammation and inflammatory extrusion. However, there was no evidence of systemic infection. Wound cultures taken from the patients showed no growth. Local debridement, irrigation, and placement of a subpectoral battery with systemic antistaphylococcal antibiotic therapy were observed in 16 patients. During a follow-up period of 37 ±12 months, pacemaker-related infections were observed in 10 patients and endocarditis in 8 of 10 patients [30]. This situation contradicts our study and may be due to the different characteristics of the patient population. All of the patients included in the study had a history of previous battery replacement, and more than half of the patients had had more than one replacement. Battery replacement has been evaluated as an independent risk factor for infection in previous studies and meta-analyses [31]. The major contemporary studies with trials of conservative treatment are summarized in Table III.

The study's limitations were its retrospective, single-centered study design and inclusion of a small number of patients. After the operation tissue culture results were not recorded and investigated.

Conclusions

Although removal of the entire system is accepted as the basic treatment for cardiac device pocket site infections, after a very rigorous evaluation, conservative treatment is considered effective and safe in the long term in patients with no evidence of systemic infection, intra-pocket abscess or fistula, vegetations on leads or valves and no previous history of battery replacement. We think this study will shed light on future studies.

Conflict of interest

The authors declare no conflict of interest.

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