Pacemaker Related Endocarditis

Analysis of Seven Cases

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SUMMARY

Vegetative electrode infection following permanent pacemaker implantation is a rare and serious complication. Among 1920 patients who underwent permanent pacemaker implantation in our institute between 1980 and 2000, 7 patients aged 65 to 78 years were diagnosed to have pacemaker related endocarditis. In this study, the clinical course and management strategies for these patients are reviewed. The most frequently encountered factors contributing to development of pacemaker infection were local complications such as postoperative hematoma and inflammation, and recurrent surgical interventions on the pacemaker system. In blood cultures S. aureus was the most common causative microorganism. Echocardiography could be performed in 5 patients. Three patients were referred to open-heart surgery for total removal of the pacemaker system, and one patient had his pacemaker system removed percutaneously. The remaining 3 patients did not agree to either surgical or percutaneous removal. These patients have been under antibiotic therapy for approximately 3 years and they still do not have any signs of a serious infection. Consequently, in patients with permanent pacemakers, infective endocarditis should be considered in the presence of fever and local symptoms. Blood cultures should be obtained and echocardiography should be performed. Complete removal of the pacemaker system with intensive antibiotic treatment is necessary for complete eradication of the infection. However, if percutaneous or surgical removal of the electrodes cannot be done because of high perioperative risk or the patient does not agree to undergo either method, medical treatment with long term antibiotic use may be considered as an alternative. (Jpn Heart J 2002; 43: 475-485)

Key words: Pacemaker, Endocarditis

Vegetative electrode infection following permanent pacemaker implantation is a serious complication that is difficult to diagnose. A diagnosis of infective endocarditis is established by the presence of clinical signs and symptoms, positive blood cultures, and the visualization of vegetation on the pacemaker elec-
trode and tricuspid valve in echocardiography.\textsuperscript{1}) Coagulase negative and positive staphylococci are responsible for most of the infections.\textsuperscript{1-11)} Echocardiography, as in native and prosthetic valve endocarditis, plays a crucial role in the diagnosis of pacemaker endocarditis. In order to eradicate an infection in permanent pacemaker related endocarditis and septicemia, the pacemaker system should be completely removed either percutaneously or surgically in addition to intensive antibiotic treatment. In this study, we present the clinical course and management of 7 cases who were diagnosed with pacemaker-related endocarditis.

**PATIENTS AND METHODS**

A total of 1920 permanent pacemaker implantations were performed in our institution between 1980 and 2000; among these, 7 cases (0.36\%) were diagnosed as pacemaker-related endocarditis. The mean age of these patients was 73±4.3 years (range; 65-78). There were 5 males and 2 females. As pacemaker endocarditis is a rare complication, a male patient who underwent pacemaker implantation in 1970 and was diagnosed with endocarditis in 1977 was also included. Blood cultures were obtained from all cases and echocardiography could be performed in 5 patients. Indications for complete removal of the pacemaker system were local infectious symptoms and signs in the pacemaker pocket, positive blood cultures, and in some cases the presence of endocardial involvement in echocardiography. All patients received antibiotic treatment for an average of 6 weeks (at least 28 days).

**CASE REPORTS**

**Case 1:** A 75-year old female patient with sick sinus syndrome underwent dual chamber (DDD) pacemaker implantation in 1981. She had 2 elective battery replacements in 1986 and 1996. However, erosion developed over the pocket region of the last implanted battery and it prolapsed outside, therefore, a new permanent pacemaker system was implanted on the contralateral pectoral region in 1998. The electrodes of a previous battery could not be removed by simple traction, so their venous ends were cut and the remaining part was left in place. Fistula and drainage developed over the skin of the previously cut venous ends of these electrodes. Antibiotic treatment with cefazolin sodium was initiated. Infectious signs and symptoms regressed following the antibiotic therapy. However, the patient was readmitted to our hospital with fever, and back and shoulder pain. Although transthoracic echocardiography failed to reveal signs consistent with infective endocarditis, the patient was clinically diagnosed as pacemaker associated endocarditis because of local signs and symptoms of infection, positive
blood cultures for *Staphylococcus aureus*, and the absence of any other focus for infection. After four weeks of vancomycin and gentamycin treatment, the clinical findings of endocarditis regressed and she was referred for open-heart surgery for complete removal of the pacemaker system. Although no vegetations were observed over the electrodes of the first implanted pacemaker during the operation, electrodes were seen to be covered with a thick pseudointimal layer and partly buried into the right atrial endocardium. The electrodes of the first implanted pacemaker battery could not be completely removed, whereas the pacemaker system that was implanted in 1998 into the left pectoral region was successfully extracted. A new epicardial electrode and permanent pacemaker (VVI) were implanted during the operation. The patient was discharged on the sixth postoperative day and antibiotic treatment was continued for 6 weeks. The patient is still asymptomatic and has been followed up with outpatient clinic visits and blood cultures for 1.5 years.

**Case 2:** A 65-year-old female patient received a single-chamber (VVI) permanent pacemaker following development of AV block after myocardial infarction in 1993. In 1994, the pulse generator was removed because of electrode dysfunction, however, the electrode could not be removed and was left in place. A new permanent pacemaker system was implanted on the contralateral pectoral region. Infection developed around the pacemaker pocket region after the new procedure and this infection was treated with antibiotics and surgical revision. The patient had no complaints between the last intervention and 1999, but then she was hospitalized in another institution with complaints of fever, shivering, and chills. Transthoracic echocardiography revealed vegetation over the electrode at the level of the tricuspid valve (Figure 1). Methicillin sensitive *S. aureus* was isolated in blood cultures, and antibiotic treatment consisting of nafcillin and amikacin was initiated. Following regression of the symptoms of endocarditis, the patient was referred to the cardiovascular surgery unit of the same institution for complete removal of the pacemaker system, but she refused to undergo the operation. The patient was readmitted to the same hospital in February 2001 because of fever, shivering, and chills and was hospitalized with the initial diagnosis of infective endocarditis. Transesophageal echocardiography revealed a vegetation of 1.5 × 0.9 cm over the tricuspid valve, and methicillin resistant *S. aureus* was isolated from blood cultures. Vegetation had disappeared by the 16th day of antibiotic treatment consisting of vancomycin and amikacin, and a 45 day course of antibiotics was completed. The patient was referred to our clinic for total removal of the pacemaker system surgically, but she still refused the operation. She has been receiving low dose oral amoxicillin since then and has been followed up for 7 months with outpatient clinic visits and echocardiographies with no serious signs or symptoms of infection.
Case 3: A 70-year-old male patient underwent dual-chamber (DDD) permanent pacemaker implantation in 1989. He was admitted to our institution in 1991 with complaints of fever, chills, cough, and chest pain that were present for a year. Blood cultures revealed *S. aureus*. Significant thickening and irregular echogenities on the ventricular electrode and moderate tricuspid regurgitation were observed in transthoracic echocardiography. Thus, the patient was diagnosed as having pacemaker related endocarditis, and antibiotic therapy consisting of vancomycin and gentamycin was initiated. Since he had typical chest pain at rest, coronary angiography was performed and two vessels disease was detected. Following six weeks of antibiotic treatment, open-heart surgery was performed, pacemaker electrodes were successfully removed, the perforated tricuspid valve was repaired, and aortocoronary bypass grafting was done. Finally, an epicardial electrode was placed intraoperatively and a single-chamber (VVIR) pacemaker was implanted. The patient is still well postoperatively and has been followed up with outpatient clinic visits for 10 years.

Case 4: A single-chamber pacemaker (VVI) was implanted in a 78-year-old male patient in 1985 for complete AV block. The battery was replaced electively twice since then, the last time in 1992. A fistula and drainage over the pacemaker pocket on his right pectoral region were observed when he was admitted to our institution in 1993 with the complaints of high fever, chills, and dyspnea. Blood culture examinations revealed *S. aureus*. Transthoracic echocardiography could not identify vegetation so he was diagnosed with pacemaker related endocarditis.

Figure 1. Transthoracic echocardiography revealed vegetation over one of the ventricular electrodes at the level of the tricuspid valve.
according to positive blood cultures and the presence of local signs and symptoms of infections. Antibiotic treatment consisting of vancomycin and gentamicin was initiated and the battery on the right side was removed, however, the electrode could not be removed by simple traction. A new single-chamber VVI pacemaker system was implanted on the contralateral side while he was under antibiotic treatment and temporary pacemaker stimulation. The patient was referred for open-heart surgery for total removal of the electrode system, but unfortunately the electrode could not be removed during the operation and he died due to heart failure that developed postoperatively.

Case 5: A 72-year-old male patient underwent permanent dual-chamber (DDD) pacemaker implantation in 1985 for complete AV block and elective battery replacement in 1991. In 1994, because an abscess was visualized at the pacemaker pocket, the pocket region was surgically revised with new battery implantation at the same site. In 1998 another revision was performed because of fistulization and drainage at the pacemaker pocket site. In 1999, as the infection recurred, the battery was removed and a new single-chamber (VVIR) pacemaker system was placed on the contralateral pectoral region. However, infection and drainage at the pocket of the right pectoral region continued. He was admitted to another institute 1 month after this procedure with fever, chills, cough, and fatigue. Transesophageal echocardiography showed vegetation over the tricuspid valve region, adjacent to the electrode (Figure 2) and S. aureus was isolated in blood cultures. Thus, the patient was diagnosed with pacemaker related infective endocarditis. He received long-term vancomycin treatment for approximately 6

Figure 2. Transesophageal echocardiography showing vegetation located on the tricuspid valve, adjacent to pacemaker lead.
months, and eventually developed renal dysfunction. Cardiac surgery for removal of the electrodes was recommended but he refused. He is still receiving chronic antibiotic treatment and he has been followed up in an outpatient clinic and by echocardiography for 2 years without any signs or symptoms of serious infection. **Case 6:** A 72-year-old male patient underwent dual-chamber (DDD) permanent pacemaker implantation for sick sinus syndrome in April 1986. Hematoma occurred twice at the site of the pacemaker pocket by November 1986 and each was drained via needle aspiration. He had complaints of fever, sweating, and fatigue in May 1987 and received antibiotic treatments until October 1987 for various diagnoses. He was then hospitalized in our institution because of persistent fever. Echocardiography could not be performed. As *S. aureus* was isolated in blood cultures and no other focus of infection was found, he was diagnosed as having infective endocarditis on a clinical basis. Antibiotic treatment that consisted of vancomycin and gentamycin was initiated, the battery was removed, the atrial and ventricular electrodes were removed by simple traction, and antibiotic treatment was continued for 6 weeks. Meanwhile, the signs and symptoms of infection regressed. During follow up, the patient did not require a pacemaker for 7 months, however, bradycardia and syncope developed so a single-chamber pacemaker (VVI) was implanted on the opposite pectoral site. The patient is still asymptomatic and undergoing follow up. **Case 7:** A 77-year-old male patient received a single-chamber (VVI) pacemaker for complete AV block in 1970. Five elective battery replacements were performed, the last one in 1996. During the last procedure an insulation defect was found in the pacemaker electrode. The electrode was left in place and a new pacemaker system was placed on the contralateral side. As he had fever after this last operation, he was hospitalized again in 1997. Blood cultures revealed *E. faecalis*. Although transthoracic echocardiography failed to show any sign consistent with infective endocarditis, transesophageal echocardiography showed thickening and irregularity possibly consistent with vegetations on the pacemaker lead (Figure 3). As no other focus of infection could be found, the patient was diagnosed with infective endocarditis and underwent 6 weeks of vancomycin treatment. The clinical symptoms and signs regressed with this treatment and he was discharged. However, after a 2-3 month silent phase, he was readmitted to the hospital complaining of fever, chills, and sweating, and improved again with the same antibiotic regimen. After recurrence of similar attacks a splenic abscess was found. Following splenectomy, the symptoms of infection regressed and he was referred to our institution for complete removal of the pacemaker system. However, he refused a cardiac operation. He has been receiving chronic oral antibiotic treatment (ampicillin) for the suppression of infection for 3 years. He has been followed up with outpatient clinic visits and echocardiography.
Results

All of our patients are older than 65 and most had a history of recurrent interventions at the site of the pacemaker pocket before the diagnosis of infective endocarditis (Table I). The mean duration between the last intervention for the pacemaker pocket and onset of symptoms was 34 months (1-108 months). Fever was the most frequent symptom, followed in order of frequency by local symptoms such as erosion at the site of the pacemaker pocket, fistulization, and drainage. All blood cultures were positive; *S. aureus* was isolated in 6 patients and *E. faecalis* was the microorganism obtained in one patient. Two-dimensional transthoracic echocardiography was performed in 6 patients and the findings were consistent with endocarditis in 3 patients (Table II). In transthoracic and transesophageal echocardiography, vegetation over the electrode and irregular thickenings were observed in two patients, whereas vegetation over the tricuspid valve was found in two other patients. Transesophageal echocardiography was only performed in 3 patients and vegetation on the tricuspid valve or irregularities in the pacemaker leads were visualized. For 1 case in which echocardiography could not be performed, and in two cases with normal transthoracic echocardiographic findings, endocarditis was diagnosed on a clinical basis according to the presence of local symptoms and signs at the site of the pacemaker pocket and positive blood cultures. Three of seven patients who were diagnosed with endocarditis refused percutaneous or surgical removal of the pacemaker system; therefore

![Figure 3. Transesophageal echocardiography showing markedly thickened and irregular view of the pacemaker lead.](image-url)
they were treated only with antibiotics. Two of these 3 patients experienced a recurrence and the infection was suppressed with antibiotics. Patients who refused the intervention have been receiving antibiotics continuously and they do not have any signs of serious infection. In one of 4 cases in which (percutaneous) intervention was performed, the pacemaker electrodes and battery were successfully removed from the body. In only one of 3 patients who was referred for cardiac surgery, the pacemaker system could be completely removed. In this patient, a perforated tricuspid valve was also repaired. In another patient the electrodes were incompletely removed. Finally, in the remaining case surgical intervention was not successful and the patient died due to postoperative heart failure. A new

<table>
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<tr>
<th>Case</th>
<th>Age</th>
<th>Sex</th>
<th>Indication</th>
<th>Pacemaker type</th>
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<td>1996</td>
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SSS=sick sinus syndrome; CAVB=complete atrioventricular block; NI=number of interventions performed at the site of the pacemaker pocket for complications or battery replacement, following first implantation.

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<th>Case</th>
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<th>Local signs</th>
<th>Blood culture</th>
<th>Vegetation in TTE or TEE</th>
<th>Follow-up (months)</th>
<th>Outcome</th>
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<td>-</td>
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<td>+</td>
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TTE=transthoracic echocardiography; TEE=transesophageal echocardiography
Septic signs=fever, chills, shivering; Local signs=erythema at pacemaker pocket, fistulization, abscess, and drainage.
permanent pacemaker system was placed epicardially or transvenously in all patients whose pacemaker systems were removed. Patients whose pacemakers were successfully removed are still asymptomatic and they have been followed up with outpatient clinic visits.

**DISCUSSION**

In the 30 years since the first implantation of a permanent pacemaker, the number of pacemaker applications is increasing due to advancements in the technologies of implantable electrophysiologic devices, extended pacemaker indications, and improved implantation techniques. Permanent pacemaker implantation brings about the risk of infection, as do all surgical interventions. The frequency of localized wound infection at the site of the operation is reported to be 2% in current series, whereas the rates of septicemia and infective endocarditis following permanent pacemaker implantation are reported to be between 0.5% to 7%. Among these infections, pacemaker endocarditis, a complication characterized by infection on the pacemaker electrode tip, tricuspid valve, or endocardial areas in contact with the electrode tip, is rare, serious, and difficult to diagnose. Factors known to contribute to the development of this infection include hematoma and inflammation following pacemaker implantation, recurrent surgical interventions for these pacemaker related complications, early manipulation of electrodes following implantation, skin erosion at the site of the pacemaker pocket, and advanced age (over 65). Four of our cases had local complications (abscess, fistula and drainage) preceding the diagnosis, whereas 6 had a history of recurrent interventions (needle aspiration, abscess drainage, pocket revision, battery replacement) at the pocket site. In most of the cases the diagnosis was based on the clinical presentation. Fever was the most common symptom in our series. In cases with pacemaker implantation, infective endocarditis should be considered in the presence of fever, local infection signs within the pacemaker pocket site, and pulmonary symptoms. Blood cultures play an important role in the diagnostic process in cases with suspected infective endocarditis. According to the literature, the most frequently encountered pathogens isolated from blood, wound, and electrode cultures of patients with pacemaker associated sepsis include coagulase positive and coagulase negative staphylococci (80%), and this is consistent with the blood culture findings of most of our patients. Echocardiography is of pivotal importance in the diagnosis of pacemaker-associated endocarditis. The aim of an echocardiographic investigation is to demonstrate the presence of any moving intracardiac mass or abscess formation over the pacemaker electrodes, tricuspid valve or endocardial structures where the electrode is placed. In our series, six of seven
cases had echocardiographic investigation and vegetations could be demonstrated over the tricuspid valve or electrodes in 4. Even though we performed transesophageal echocardiography in only three patients, it is known to be much more sensitive than transthoracic echocardiography (90% vs 30%) in diagnosing pacemaker associated infective endocarditis, and today transesophageal echocardiography is the preferred imaging method for demonstrating a vegetation located on an endocavitary pacemaker electrode.\(^2,11,16,20,22\)

The preferred optimal treatment of pacemaker-associated endocarditis is to initiate intensive antibiotic treatment and totally remove the pacemaker system as soon as possible following regression of signs and symptoms.\(^2,6,14-16,23\) In cases where electrodes could not be removed percutaneously, with high operative mortality, or when the patient refuses either method, medical treatment may be the sole alternative. Three patients in our series received only antibiotic treatment because they refused both methods. Although recurrence occurred in two of these cases and this recurrence was suppressed with a second long-term antibiotic course, these patients are still receiving chronic antibiotic therapy without any signs or symptoms of serious infection.

According to our experience with these cases, when taking into account difficulties in the diagnosis and treatment of pacemaker-related infection, routine preoperative antibiotic prophylaxis is of great importance, especially in the elderly. Local complications such as hematoma formation should be minimized by using a careful surgical technique. Recurrent surgical interventions for local complications and early manipulation of electrodes should be avoided. In cases of recurrent local infection, withdrawal of the pacemaker system and contralateral implantation of a new pacemaker system should not be delayed.

**REFERENCES**