Original article

Intra-cardiac pacemaker infection: Surgical management and outcome

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Abstract

Background: Pacemaker infections are rare, but serious complications of pacemaker therapy. The generator pocket, the pacing leads, or both may be involved.

Methods: We report 21 patients with infected pacemaker systems. All had infected pacemaker and pacemaker leads with tricuspid valve endocarditis. Pacemaker systems were completely removed in all patients. Extracorporeal circulation with beating heart was employed for the explantation of infected pacing leads, generator and removal of vegetations on tricuspid valve and repair of tricuspid valve. Then a permanent epicardial pacemaker lead was inserted.

Results: No complications occurred in patients with localized generator pocket infections. Two patients with infected leads, who were preoperatively already in a serious clinical condition, died of septic shock in the early postoperative period. No recurrent infections were observed.

Conclusion: Explantation of the complete pacemaker system has proved a reliable method to eradicate infection. Complications were rare, except in patients who present lately in a critically ill condition and septic shock.

Keywords: Heart (general subjects); Pacemaker; Endocarditis; Pacemaker lead infection; Tricuspid valve

1. Introduction

Since the first implantation of a completely implantable pacemaker by Elmqvist and Senning in 1958, pacemaker implantation has rapidly become a routine procedure. Most frequently, pacemaker leads are introduced through the cephalic or subclavian vein using direct exposure or introducer techniques and advanced into the right atrium and ventricle. Pulse generators are placed above or beneath the pectoralis major muscle. Alternatively, the leads can be fixed to the epicardium and the generator stored in the anterior or posterior sheath of the rectus abdominis muscle. Among possible complications, infective endocarditis of intracardiac pacemaker leads is of particular clinical importance. It is a rare, but serious, complication and can become life-threatening [1].

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The clinical use of permanent pacemakers has grown considerably over the past 2 decades. A growing list of indications for permanent pacemakers and the increase in the geriatric population mean that more patients undergo pacemaker insertion. Therefore, there is a larger population at risk of infection [2].

Cardiac device infective endocarditis (IE) is an infrequent but potentially lethal infectious complication of pacemaker. Infection of the pacemaker pouch and wire may occur in 1–7% of implanted pacing systems, and mortality rates in cardiac device endocarditis have been reported to be 30–35% [3]. Risk factors for cardiac device endocarditis include chronic conditions such as diabetes mellitus, malignancies, immunosuppressive therapy, and local factors related to the pacing system such as erosion of the pacemaker pouch, and the number of previously inserted leads. Despite advances in diagnostic approaches, treatment of cardiac device endocarditis is still controversial. Medical treatment has been reported to be successful in some cases [4,5]. However, there is increasing evidence that the entire pacing system should be removed to achieve complete infection eradication [6].

In this report we summarize our experience with pacemaker intracardiac lead infections and include recommendations for surgical treatment with or without tricuspid valve endocarditis.

2. Patients and methods

2.1. Patients’ characteristics

All patients were referred to our cardiac surgery department in National heart institute, Cairo, Egypt from cardiology department with resistant infection of cardiac pacemaker, intra-cardiac lead vegetations and tricuspid valve endocarditis during 8 years duration from March 2007 to June 2015.

In this 8 years duration, 21 patients (12 males, 9 females) with an average age of 29 years (±9.4 SD) were referred to our institution for the treatment of infection of their pacemaker systems. In 5 patients, the original pacemaker was implanted in different hospitals and 16 patients had undergone pacemaker implantation at our institute. The indications for pacemaker implantation for the 16 patients initially implanted at our institute were sick-sinus syndrome (n = 3) and third-degree atrioventricular block (n = 13). In all patients, pacemaker leads had been implanted transvenously through the cephalic or subclavian vein and the pacemaker generators positioned on the pectoralis major muscle.

2.2. Clinical findings, complications and diagnosis

Six patients had history of infected generator pocket and 2 of them suffered from diabetes mellitus. At time of surgery; five patients presented with intracardiac infection without pocket infection and sixteen patients had infected leads with infected pocket (eleven patients had erosion of the skin of the pocket and five patients showed healed pocket infection with intact skin). All patients with a lead infection presented with symptoms of sepsis. 2 patients suffered from septic emboli to the lungs that had led to recurrent pneumonia.

Diagnosis was continued by obtaining blood cultures and the presence of vegetations on pacemaker leads was confirmed on the basis of transthoracic and trans-esophageal echocardiographic findings. All patients suffered from infected pacemaker leads with vegetations attached to them and the tricuspid valve. All patients were found to have vegetations attached to the tricuspid valve. Five of them had additional thrombi in the right atrium and three patients were found to have masses of thrombi extending from the pacing leads to both the right atrium and ventricle. (Fig. 1–3).

2.3. Perioperative management

Our perioperative strategy included adequate antimicrobial therapy which started when the diagnosis was established and altered when the causative microorganisms were identified. If cultures still grew no organisms, broad-spectrum antimicrobial therapy directed against organisms most commonly responsible for causing pacemaker infections was initiated. Operation was postponed until signs of infection and sepsis had disappeared.

2.4. Operation

Infected pacemaker leads in all patients were removed with the aid of extracorporeal circulation. Total cardiopulmonary bypass was instituted after cannulation of the ascending aorta and superior and inferior venae cavae. Intracardiac surgical procedures were performed on an empty beating heart without the application of cardioplegic solution or aortic cross-clamping. Bi-caval cannulation allowed the right atrium to be opened in a rather bloodless field, with a sufficient view and exposure of the infected leads, the
tricuspid valve, and the right ventricle. Using this access, all leads surrounded by masses of vegetations could be removed from the intracardiac cavity (Fig. 4). The pacemaker generators were explanted at the site of implantation.

In all patients, septic thrombi in the right atrium and ventricle were resected and vegetations attached to the tricuspid valve were removed trying to preserve the leaflets. Additional thrombi were removed from pulmonary artery in one patient and from superior
vena cava in two patients. In 14 patients the tricuspid valve was reconstructed after an incision of the annulus or a partial leaflet resection had become necessary to remove an entrapped lead or attached vegetations. The tip of the pacemaker lead has to be dissected from right ventricle cautiously to avoid right ventricular injury, rupture or perforation.

Epicardial pacemaker electrode was then implanted on ventricular surface, passing it outside the pericardium from superior mediastinum up to the contralateral side just over the sternoclavicular joint subcutaneously to the new pocket in pectoral area or passing it to a peri-peritoneal pocket in the upper abdominal area. The electrode was connected to the generator at the new pocket, tested and the pocket was closed. Bypass time ranged from 15 to 50 minutes (mean 27.2 min, SD 9.2) according to the procedure done for repair of tricuspid valve.

3. Results

3.1. Microbiology

All the patients had explantation of the entire pacing system but culture of the leads was not performed in two cases. In all patients, specimens of infected tissue or swabs from wounds and blood samples were obtained for Gram staining, culture and susceptibility studies. The causative organism was mostly a staphylococcus species: S epidermidis in 14 patients, S aureus in two, and mixed S aureus and S. epidermidis in one. Other cases included Pseudomonas (2 patients), Klebsiella (one patient), E coli and Serratia marcescens (n = 1). The patient with E coli had chronic prostatitis for two years.

3.2. Postoperative course

No intraoperative or postoperative complications occurred in the patients with infected pacemaker pockets. No intraoperative or postoperative complications related to the surgical technique were seen in patients with infected leads. Two patients with infected leads, who were preoperatively already in a serious clinical condition, died of septic shock in the early postoperative period due to multi organ failure in spite of full medical treatment supportive for septic shock before and after surgical treatment.

No recurrent infections were observed.

All patients had intra-operative implantation of permanent pacemaker with the epicardial lead connected to the systemic ventricle and the battery inserted in a peri-peritoneal pocket or the contralateral pectoral area.

Postoperative follow up period ranged from six months to two years.
4. Discussion

Infection of the pacemaker system may be limited to the pacemaker pocket, it may only involve the leads, or it may include the whole pacemaker system. Infection of the pacing leads results in more severe clinical symptoms, because vegetations attached to the leads may cause infective endocarditis and promote thrombus formation in the superior vena cava and right atrium and ventricle, leading to the development of septicemia and the acute or recurrent formation of a pulmonary embolism. The incidence of pacemaker infection is currently reported to range from 0.5% to 1.5%, [7,8].

The diagnosis of pacemaker infections is established by the nature of the clinical symptoms and the results of blood testing as well as ultrasonographic and radiologic imaging. Echocardiography is a sensitive method for detecting intracardiac vegetations adherent to the pacing leads. Transesophageal echocardiography is subsequently performed if transthoracic ultrasonography fails to show suspected intracardiac vegetations [9] Findings yielded by microbiologic analysis of specimens of the infected tissue and foreign bodies as well as blood cultures may help to identify the microorganisms so that subsequent adequate antimicrobial therapy can be instituted. The most common bacteria are those that physiologically colonize the skin, such as the various types of staphylococci, among them Staphylococcus epidermidis and Staphylococcus aureus.

The most efficient treatment of pacemaker infection is the complete removal of the pacemaker system, including the generator and leads, regardless of the extent of the infection. We prefer to remove infected leads during cardiac operations using extracorporeal circulation because this procedure has several advantages over the intravascular extraction methods, besides being associated with a similar low overall risk. Specifically, the risk of mechanical injury to cardiac structures and dissemination of vegetations is less because the leads are not exposed to mechanical stress and blood circulation through the right heart is interrupted during the procedure. However, the extraction of infected leads through a purse-string suture with the heart beating, as described by Niederhäuser and associates [10], still carries the risk of incompletely removing vegetations, with subsequent dissemination. An open heart operation also allows additional surgical procedures to be performed in the right heart, such as reconstruction of the tricuspid valve or the removal of intracardiac vegetations and thrombi, which was necessary in all patients.

The preoperatively started antimicrobial therapy was continued for at least 4 weeks after implantation of the new pacemaker. The new pacemaker was implanted through a different implantation site, usually the contra lateral pectoralis region or the upper abdominal area [11,12]. All patients in whom either strategy was used remain free of infection so far.

In conclusion, the most efficient treatment for intracardiac pacemaker infections is the complete removal of the pacemaker system. The removal of infected leads during extracorporeal circulation prevents mechanical injury as well as the spread of infection and allows additional intracardiac procedures to be performed, if necessary.

Conflict of interest

The authors declared no conflicts of interest with respect to the research, authorship, and/or publication of this article.

References


