Permanent Ventricular Pacing for Symptomatic Bradycardia Patients at Maharat Nakhon Ratchasima Hospital: One-Year Experience

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ABSTRACT

Background: Permanent pacemaker implantation is the main therapy for bradyarrhythmic patients with associated symptoms related to bradycardia. The relative ease and low risk of implantation make them an attractive choice for the treatment of symptomatic bradycardia.

Objective: To report the experience of implantation of cardiac permanent pacemaker at the Cardiovascular Disease Center, Maharat Nakhon Ratchasima Hospital.

Materials and methods: We performed permanent pacemaker implantation during June, 2001 and May, 2002 in 31 symptomatic bradycardia patients with ventricular pacing mode (VVI) at cardiac catheterization laboratory. The permanent pacemaker was implanted by inserting the pacing lead via subclavian vein by venipuncture and pulse generator was implanted subcutaneously at the left pectoral region.

Results: Thirty-one symptomatic bradycardia patients were implanted with ventricular pacing permanent pacemaker, most patients were females (12 males, 19 females) with mean age of 62.87$\pm$14.45 years. Most patients had symptoms of fatigue and up to 50% had syncope at presentation. Electrocardiograms (ECGs) were recorded in all patients. Most patients had third degree atrio-ventricular (AV) block (77.4%) and the remaining ECGs were sinus node dysfunction (20%). Cardiac pacemaker implantation was successfully performed in all patients with no immediate complication. Lead parameters at implantation were as follows: threshold 0.3-0.7 V (mean 0.5 V), lead impedance 520-1,470 Ohms (mean 827 Ohms), and R wave 3.8-27.3 mV (mean 11 mV). There were two complications during follow up, one patient with infected pacemaker 3 months after implantation and the other one with lead displacement 1 week after implantation. Both of them were successfully treated.

Conclusion: Pacemaker implantation is intended to free the patient from health-related limitations. It is the main treatment of symptomatic bradycardia and can be performed easily with minimal complication.

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บทคัดย่อ: **การใส่เครื่องกระตุ้นหัวใจห้องล่างขวาชนิดถาวร ที่ศูนย์โรคหัวใจและหลอดเลือด โรงพยาบาลมหาราชนครราชสีมา: ประสบการณ์ 1 ปี**

พินิจ แก้วสุวรรณะ พ.บ.

ศูนย์โรคหัวใจและหลอดเลือด กลุ่มงานอายุรกรรม โรงพยาบาลมหาราชนครราชสีมา นครราชสีมา 30000

เวชสารโรงพยาบาลมหาราชนครราชสีมา 2545;26:67-74.

บทนำ: การใส่เครื่องกระตุ้นหัวใจห้องล่างขวาชนิดถาวร (permanent cardiac pacemaker, ventricular pacing mode, VVI) ถือเป็นการรักษาสำหรับผู้ป่วยที่มีภาวะหัวใจเต้นช้าและมีอาการจากภาวะดังกล่าว โดยที่สาเหตุของภาวะหัวใจเต้นช้านั้น ไม่สามารถแก้ไขให้หายขาดได้

วัตถุประสงค์: เพื่อรายงานประสบการณ์การใส่เครื่องกระตุ้นหัวใจห้องล่างขวาชนิดถาวร ที่ศูนย์โรคหัวใจและหลอดเลือด กลุ่มงานอายุรกรรม โรงพยาบาลมหาราชนครราชสีมา

ผู้ป่วยและวิธีการ: ผู้ป่วยที่มีอาการจากภาวะหัวใจเต้นช้า (symptomatic bradycardia) ที่มารับการรักษาที่ศูนย์โรคหัวใจและหลอดเลือด กลุ่มงานอายุรกรรม โรงพยาบาลมหาราชนครราชสีมา ระหว่างวันที่ 1 มิถุนายน 2544 ถึง 31 พฤษภาคม 2545 เป็นระยะเวลา 1 ปี

ผลการศึกษา: มีผู้ป่วยที่มาด้วยอาการของภาวะหัวใจเต้นช้า และได้รับการใส่เครื่องกระตุ้นหัวใจห้องล่างขวาชนิดถาวร จำนวนทั้งหมด 31 ราย เป็นเพศชาย 12 ราย เพศหญิง 19 ราย อายุเฉลี่ย 62.87±14.45 ปี ผู้ป่วยส่วนมากมีอาการเป็นลมหมดสติถึงร้อยละ 50 ที่เหลือมีอาการเหนื่อยไม่มีแรง เวียนศีรษะ แน่นหน้าอก ผู้ป่วยทุกรายได้รับการตรวจคลื่นไฟฟ้าหัวใจ และพบว่ามี third degree atrio-ventricular (AV) block 24 ราย (ร้อยละ 77.4) และ sinus node dysfunction 7 ราย (ร้อยละ 20) ทั้งหมดได้รับการใส่เครื่องกระตุ้นหัวใจห้องล่างขวาชนิดถาวร โดยสอดสายกระตุ้นทางหลอดเลือดดำ subclavian (subclavian venepuncture) โดยไม่มีปัญหาขณะใส่ ค่า lead parameter ขณะใส่คือ ค่า threshold 0.3-0.7 V ค่าเฉลี่ย 0.5 V, impedance 520-1,470 Ohms ค่าเฉลี่ย 827 Ohms, R wave 3.8-27.3 mV ค่าเฉลี่ย 11 mV เมื่อติดตามการรักษาพบว่ามีปัญหาติดเชื้อบริเวณที่ใส่ 1 ราย (3 เดือนหลังใส่) สายกระตุ้นหลุด 1 ราย เกิดขึ้นหลังจากใส่เครื่องไปแล้ว 1 สัปดาห์ ทั้ง 2 รายได้รับการแก้ไขเป็นที่เรียบร้อย

สรุป: การใส่เครื่องกระตุ้นหัวใจห้องล่างขวาชนิดถาวร ถือเป็นการรักษาที่ได้ผลดีในผู้ป่วยที่มีอาการจากภาวะหัวใจเต้นช้าที่ไม่สามารถแก้ไขสาเหตุได้ และการใส่เครื่องสามารถทำได้ง่ายโดยที่ไม่พบมีภาวะแทรกซ้อนที่รุนแรงเกิดขึ้น

The first electronic pacemaker was a transcutaneous device developed by Zoll in 1952 for the treatment of life-threatening bradycardia[1]. With miniaturization of the pulse generator and direct myocardial leads, implantation of the first internal cardiac pacemaker in human was performed in 1958[2]. Compared with these early fixed-rate devices, technological advances have enhanced the sophistication of modern cardiac pacemaker that have dramatically increased their versatility. The relative ease and low risk of implantation make them an attractive choice of therapy in variety of bradyarrhythmic patients.

The American College of Cardiology/American Heart Association Task Force on Practice Guidelines, Committee on Pacemaker Implantation periodically publishes guidelines for the implantation of pacemaker[3]. The indication for placement of permanent pacemakers in bradyarrhythmic patients are third or second degree atrio-ventricular (AV) block and sinus node dysfunction with associated symptomatic bradycardia and symptomatic chronotropic incompetence. Implantation of permanent pacemaker should also be performed in asymptomatic third degree AV block if average awake ventricular rate < 40 bpm, in asymptomatic type II second degree AV block, in asymptomatic type I second degree AV block at intra or infra His level. Documented asystoly > 3 seconds is also recommended to performed permanent pacemaker implantation.

The purpose of this study is to report our experience in permanent pacemaker implantation with ventricular pacing mode (VVI) in symptomatic bradyarrhythmic patients including the technique, result and complication of the procedure.

Patients and Methods

Patients: We performed permanent pacemaker implantation during June, 2001 and May, 2002 in 31 symptomatic bradycardia patients with ventricular pacing mode (VVI) at cardiac catheterization laboratory.

Equibment: Single chamber pacemaker with ventricular pacing mode (VVI), consists of a pulse generator and the pacing lead.

Implantation technique:

Preparation: Informed consent must be obtained from the patient before the procedure. The procedure and its risks were explained. Before the procedure, the history and physical examination and laboratory examination should be reviewed. Some basic laboratory data should be scrutinized before the procedure. The chest x-ray and electrocardiogram (ECG) were part of the original evaluation in all patients. Some patients were investigated with exercise stress test, echocardiography or coronary angiogram that depended on the clinical indication for each investigation.

The patients were fasted for at least 6 hours. Prophylactic antibiotic therapy was given before the procedure. At our institution, all patients received 1 gram of intravenous cefazolin during the procedure followed by 48 hours of therapy.

Venous access: A variety of techniques are available for gaining venous access. We prefer the subclavian vein venepuncture procedure. Using this approach, we can achieved venous access under local anesthesia and there is no risk of pneumothorax. We prefer the left pectoral location for ease of lead introduction and positioning for the right handed patients. Once venous access had been achieved and a guidewire was in place, the wire was used to guide the insertion of venous sheaths.

Lead placement: After the venous sheath was introduced into the vein. The sheath is of the "peel-away" type, to allow its removal after the lead was introduced. When the sheath's dilator was removed, the sheath itself should be pinched to prevent both excessive bleeding and air embolism. The lead was inserted immediately to minimize the time that the sheath was open to air. Because pacemaker leads were designed to be flexible

to prevent cardiac perforation so the stiffening wire stylet must be used to manipulated the lead. The sheath was then withdrawn from the vein and removed. We then shaped a stylet with a curve at its distal 10-12 cm. Using the curved stylet, the lead was advanced across the tricuspid valve and into the right ventricular outflow tract. Then using a straight stylet, the lead was withdrawn from outflow tract and then advanced to the apex of right ventricle. Ventricular ectopy was common during lead manipulation and almost always stop when the lead position was stable. If ventricular tachycardia persist the lead should be repositioned. After lead was positioned in the proper area, sensing of R waves, pacing threshold and lead impedance were then checked for acceptable function. Once good positioning of the lead had been confirmed, it was anchored to the deltoid and pectoris fascia using a strong nonabsorbable suture. The sutures were tied around an anchoring sleeve that should advanced over the lead to a position in the deltopectoral groove. Lead parameters were again checked to ensure that no detrimental change had occurred while the anchoring sutures were placed.

Pulse generator implantation and pocket closure: After further local anesthesia, a subcutaneous pocket was made with blunt and sharp dissection, then irrigated liberally with antiseptic solution. The pacemaker pulse generator was connected to the lead and secured in place. The system was then implanted into the pocket with the lead coiled behind the generator to minimize the risk of damage to the lead in the event of reincision. The ECG monitor was then examined to ensure appropriate pacing and sensing. If the patient was in sinus rhythm, we placed a sterile magnet over the generator to ensure that it will pace in asynchronous mode. The pocket was closed with two layers of an absorbable suture.

Results

Thirty-one patients (12 males, 19 females; mean age 62.87±14.45 years, range 24-84 years) with symptomatic bradycardia were performed permanent pacemaker implantation in the catheterization laboratory at the Cardiovascular Disease Center, Maharat Nakhon Ratchasima Hospital. Most patients in this study were female and the most common presenting symptoms were fatigue and syncope. The other symptoms were palpitation, dizziness and chest discomfort. Table 1. showed patient characteristic and the detail of presenting symptoms of the patients.

Table 1. Patient characteristic and presenting symptoms

Patient characteristic		
Sex (no.) (%)	Male	12 (38.7)
	Female	19 (61.3)
Age (year)	Mean ± SD	62.87±14.45
	Range	24-84
Mean age- male (year) (mean ± SD)		65.41±11.27
Maen age-female (year) (mean ± SD)		61.26±16.22
Diabetes mellitus (no.) (%)		4 (13.0)
Hypertension (no.) (%)		7 (22.6)
Presenting symptoms (no.) (%)		
Syncope		15 (50.0)
Fatigue		23 (74.2)
Palpitation		4 (12.8)
Dizziness		2 (6.5)
Chest discomfort		9 (29.0)

ECG was recorded in all patients at the initial presentation. The most common ECG finding were third degree AV block and followed by sinus node dysfunction. Some patients were investigated with exercise stress test, echocardiography and coronary angiogram depended on the clinical indication. Table 2. summarized the ECG diagnosis and the results of cardiac investigation.

Cardiac pacemaker implantation were performed successfully in all patients with lead parameter at implantation were shown in Table 3. Most patients could achieve lead parameter (threshold, impedance, and R wave) in an acceptable values.

The first routine follow up after implantation was to ensure adequate wound healing and consistency of sensing and thresholds, further follow up should performed periodically. Routine follow up always include a history of any new symptoms as well as an examination of the pocket site for erythema, edema, tenderness, or threatened erosion. There were 2 complications occur during follow up, 1 patients with infected pacemaker 3 months after implantation and 1 patient with lead displacement 1 week after implantation. Both of them were successfully treated.

Table 2. ECG diagnosis and cardiac investigation results

	No. of patient (%)
ECG finding	
- Thrid degree AV block	24 (77.4)
- Sinus bradycardia	5 (16.1)
- Second degree AV block type II (Mobitz II)	1 (3.2)
- Sinus pause	2 (6.4)
- Rapid atrial fibrillation	1 (3.2)
- Junctional escape beat	2 (6.4)
- Premature ventricular beat	1 (3.2)
Cardiac Investigation	
- Exercise stress test	2*(6.4)
- Echocardiography	13† (42.0)
- Coronary angiography	7‡ (22.6)

*1 negative, 1 positive

†11 normal, 2 LV dysfunction

‡ All normal

Table 3. Lead parameter at implantation

Lead Parameter	Range	Mean
Threshold (V)	0.3-0.7	0.5
Impedance (Ohms)	520-1470	827
R wave (mV)	3.8-27.3	11

Discussion

When the patient with underlying chronic or recurring bradyarrhythmia that the causes cannot be corrected have symptoms that related to bradycardia, the most appropriate therapy will often be a permanent pacemaker implantation. Implantation of a permanent pacemaker should offer either alleviation of symptoms or prevention of future morbidity or mortality. The symptoms of bradycardia are caused by poor organ perfusion in the setting of inadequate cardiac output. These include fatigue, lightheadedness or dizziness, and frank syncope. Bradycardia may also exacerbate myocardial ischemia causing angina or precipitating congestive heart failure. In our series the most common presenting symptoms were fatigue and frank syncope.

Symptomatic bradycardia is a general term that encompasses several disorders of the sinus and the AV

node. Sinus node dysfunction is one of the most common causes of profound symptomatic bradycardia and has become the most common indication for pacing. Pacing therapy has been demonstrated to be superior to medical therapy with theophylline for patients with sinus node dysfunction[4]. The sick sinus syndrome, in which the sinus node fails to generate an adequate heart rate, is an example. Other syndromes include chronotropic incompetence, in which an adequate heart rate at rest fails to elevate with exertion or physiologic stress. Historically, sinus node dysfunction represents the diagnosis leading to implantation in about one half of all pacemaker recipients in the United States[5]. Sinus bradycardia itself is rarely an indication for pacing in the absence of symptom[6]. Before deciding on pacemaker implantation, the bradycardia should be shown to be associate with symptoms. Ambulatory monitoring is a useful tool in this regard. In this study, we found sinus node dysfunction and sinus bradycardia for 20%, but we do not do ambulatory monitoring ECG because we do not have an equipment, so we assume that the symptoms are correlate with bradycardia.

Disorders of AV node conduction frequently cause symptoms. Second or third-degree AV block may also cause symptoms, depending on the rate of the infranodal escape mechanism. Type II second degree AV block and third degree AV block are usually caused by disease in the His-Purkinje system, and type II second degree AV block may progress unpredictably to third degree block[7]. We found complete AV block to be the cause of symptomatic bradycardia for 77.4% in this study.

Nearly all pacemakers are implanted through a transvenous approach by either cardiologists or surgeons. The choice of using an operating room or a catheterization laboratory for the implant procedure probably plays little role in procedural related complications, but a cardiac catheterization laboratory involves lower hospital costs[8,9].

Currently, pacemaker leads are usually implanted tranvenously and the pulse generator is implanted in a subcutaneous pocket in the pectoral region. A variety of techniques are available for gaining venous access. The cephalic, axillary and subclavian veins can all be utilized. The subclavian puncture is performed without direct visualization, there is a risk of pneumothorax and subclavian artery puncture and the potential for crush injury to the lead that may occur as they pass between the clavicle and first rib. Althoug subclavian vein venipuncture will have such problems, we prefer to use this approach because it is technically easier. We do not found any pneumothorax or lead fracture in our patients.

After the lead was positioned in right ventricular apex, we examine the electrogram from the lead to ensure ventricular sensing and pacing parameters. Acceptable implant values are shown in Table 4.

Table 4. Acceptable value of lead parameters at implantation

Lead parameter	Ventricular lead desirable	Acceptable
Stimulation threshold (V)	< 0.7	< 1.0
Impedance (Ohms)		400-1,000
Sensed R wave (mV)	> 10	> 5

Most patients in our institue could achieved lead parameter at acceptable value except 3 patients who have impedance more than 1,000 Ohms and one patient who has sensed R wave less than 5 mV.

The risk associated with transvenous implantation of a permanent pacemaker is low[10,11]. Nonetheless, complications do occur (Table 5)[12]. The patient should be told of the risk of bleeding and vascular injury. Placement of lead is often accompanied by ectopy. Sustained tachycardia requiring therapy is rare, and it is uncommon that urgent cardioversion or defibrillation is necessary. We do not found sustained tachycardia in our patients. There is a small risk of perforation of the thin-walled right ventricle with the lead. Lead dislodgment is most likely to occur early after implantation (within a day). In the event of lead dislodgment, lead revision should be carried out as soon as feasible to minimize the scarring and fibrosis around the lead. One patient in our study has lead dislodgment a week after implantation and lead revision has been performed with successful.

Table 5. Complications of transvenous pacemaker implantation

Early complication	Late complication
Infection	Lead dislodgment
Bleeding	Erosion of skin over pocket
Pneumothorax/hemothorax	Pain
Air embolism	Infection
Arterial cannulation	Lead fracture
Perforation of heart/tamponade	Lead insulation failure
Atrial fibrillation	Migration of pulse generator
Heart block	Twisting and fracture of lead due to manipulation of generator-Twiddler's syndrome
Deep vein thrombosis	
Lead damage/fracture	
Lead dislodgment	
Ventricular tachycardia	
Pocket hematoma	
Incorrect connection of lead to pulse generator	

The most feared complication of pacemaker implantation is infection. If there is evidence of systemic infection such as fever, positive blood cultures, removal of the entire system is indicated to allow antibiotic therapy to clear the infection completely. The gravity of the risk of infection should serve to emphasize the need for attention to sterile technique. Before pulse generator implantation, we use the antiseptic to irrigate the pocket. And we prefer to give antibiotic prophylaxis with cefazolin during implantation and 48 hours later. One patient in our study develops infection at the site of implantation 3 months after the precedure and the patient was treated with systemic antibiotic for 14 days without removal of the pacemaker.

Conclusion

Pacemaker implantation is intended to free the patient from health-related limitations. It is a main treatment of symptomatic bradycardia that causes can not be corrected. However, patients are frequently anxious that their condition of having an implanted device will result in more illness, not less. The patient should be reassured that after recovery from the implantation procedure, the patient should be able to proceed with normal activities of life.

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