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THE ROLE OF PACEMAKER CLINIC IN THE FOLLOW-UP OF PATIENTS WITH PERMANENT PACEMAKERS

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ABSTRACT

The Pacemaker Clinic at Shahid Rajai Cardiovascular Research Center first started operating in August 1992. In its first year of operation, 294 permanent pacemaker patients were studied, allowing an appraisal to be carried out of the clinic's effectiveness in diagnosing and treating early complications. In the final analysis, pacemaker complications were observed in 68 (23%) patients, of whom 38 (56%) were treated by reprogramming the unit and without requiring any operation.

The most common type of pacemaker complication observed was "undersensing" in 20 (29.5%) patients, followed by lack of myocardial capture by the pacemaker in 17 (25%) patients.

Keywords: Pacemaker, Undersensing, Myocardial Capture.

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INTRODUCTION

Thirty-five years have passed since the invention of permanent pacemakers. Despite great technological advances in the field of electronics, as yet the battery life in these pacemakers is anything but permanent. For example, the battery life for single chamber pacemakers is between 7-12 years and for dual chamber pacemakers, 4-8 years. In addition, after implantation of a pacemaker there are diverse complications threatening its proper functioning which can either be prevented by constant care, follow-up, and adequate training of patients, or treated before occurrence of an accident (Table I).

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With reference to increasing usage of permanent pacemakers and the probability of various complications occurring, it is necessary for permanent pacemaker patients to be checked regularly according to a standard schedule. Nearly all pacemakers currently utilized have the potential for telemetry and programmability. By using these two capabilities, timely diagnosis of most malfunctions affecting pacemaker performance can be rectified. This study based on data collected during a 12–month period affirms the need for centers to provide regular check–ups for patients with permanent pacemakers, and demonstrates how–with utilizing pacemaker analysis technology–many pacemaker complications can be corrected without the need for lead or pulse generator explantation and replacement surgically.

MATERIAL AND METHODS

This study commenced in August, 1993 at Shahid Rajai

Table I. Pacemaker malfunctions.

Disorder	Number of Patients	Reprogrammed	Operated
Under-sensing	20(29.5%)	9	11
Lack of Myocardial Capture by Impulse Pacemaker	17(25%)	11	6
High Energy Output Level	13 (19%)	13	0
Improper Pacemaker Mode	7 (10%)	5	—
Lack of Pacemaker Output	4 (6%)	0	4
Reduction in Pacemaker Energy Output	4 (6%)	0	4
Muscle Twitching	3 (4.5%)	2	1

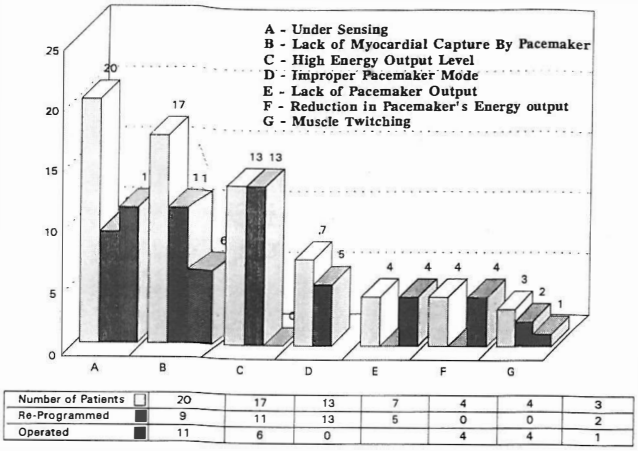
Cardiovascular Research Center's Pacemaker Clinic with the following resources:

a) Human resources: 1- Cardiovascular specialist, 2- Assistant cardiologist, 3- Statistical consultant, 4- Computer supervisor, 5- Secretary, and b) Technical resources: 1- Single and three-channel electrocardiogram monitors, 2- Defibrillator, 3- Temporary transthoracic pacemaker, 4- Pace analyzer and programmers, 5- Pace analyzer (Mini-Clinic), 6- Magnet, and 7- 386 computer with electro- and vector cardiography supplement and printer.

All patients who have had a permanent pacemaker implantation are examined by the clinic before they leave hospital. One day per week has also been allocated by the clinic for examining patients who have received a permanent pacemaker in the past years.

Patients coming to the clinic are visited by the attending physician in charge, who investigates any complaints and also examines the site of pacemaker implantation. Next the patient's cardiac rhythm is monitored and where telemetry is feasible, by utilizing special analysis, pacemaker function is further investigated. According to the type of the pacemaker implanted, various parameters like pace rate, pace amplitude, sense amplitude, pulse width ... etc, are studied. Where telemetry is not possible, by utilizing mini-clinic, pulse width and pace rate are measured and by placing the magnet over the pacemaker, the magnet rate is measured.

All patients are issued a pictured identification card and a unique computerized record of their personal details and type of pacemaker is made. In addition patients are advised after discharge from hospital to visit the clinic for check-ups at 4-week and 8-week intervals after the date of pacemaker implantation. In cases where no problems are encountered,



patients are asked to return for check-ups every 12 months for single chamber and every 6 months for dual chamber pacemakers.

RESULTS

Since it began activity, a total of 294 patients with permanent pacemakers have visited the clinic. Of this total, 54% were female and 46% male and their age distribution ranged from 4 to 90 years old with an average age of 59 years.

The most common reason for pacemaker implantation has been complete heart block (61%), followed by sick sinus syndrome (33%). According to NASPE (North American Society of Pacing and Electrophysiology) classifications, the VVI pacemaker mode has been most often chosen (83%), and the most common location for situating the pacemaker lead has been in the right ventricle (93%). Telemetry and programming was feasible in 235 patients (80%).

While examining the above patients, various pacemaker malfunctions were observed in 68 of them (23%), which are listed below in order of prevalence.

1. Undersensing in 20 cases (29.5% of pacemaker malfunctions). In 9 (45%) patients, this was corrected by reprogramming and the others required operation.

2. Lack of myocardial capture by the pacemaker in 17 cases (25% of pacemaker malfunctions). In 11 (65%) patients this was corrected by reprogramming, and the remainder required surgery.

3. High energy output level in excess of amount required to pace (with safety limit taken into account), leading to premature battery depletion in 13 patients (19% of pacemaker malfunctions). In all 13 (100%) patients this was corrected by reprogramming and determining the lowest level of pacing threshold, resulting in increased battery life.

4. An improper pacemaker mode which was in conflict

with the patient's life style or other physiological conditions in 7 cases (10% of pacemaker malfunctions). In 5 cases the mode was altered to the chosen one by reprogramming the pacemaker and the remaining patients were followed.

5. Lack of pacemaker output in 4 patients (6% of pacemaker malfunctions). In all 4 cases (100%) reoperation was required to correct the problem.

6. Depletion of pacemaker output which showed itself with increased automatic interval (time interval between two consecutive pace beats by locating the magnet on pacemaker) in 4 patients (6% of pacemaker malfunctions). This indicates relative pacemaker battery depletion. All 4 cases were referred for elective pacemaker exchange for a new one.

7. Muscle twitching coinciding with pacemaker stimulation in 3 cases (4.5% of pacemaker malfunctions). In 2 (67%) cases the problem was solved by reprogramming and in 1 case reoperation was required.

Total- 294 Patients, 54% Male, 46% Female

Most common type of pacemaker implanted VVI (83%)
Most common location of pacemaker implantation Righ Ventricle (93%)
Telemetry feasibility 235 patients (80%)

Most common reason for pacemaker implantation (from a prevalence point of view):

1- Complete heart block	61%
2- Sick sinus syndrome	33%

DISCUSSION

Briefly, pacemakers consist of the following parts: 1) pulse generator, and 2) lead or electrode. The pulse generator itself is made up of 1) power source (battery), 2) impulse generator (external circuit), and 3) time control circuit. The lead is just a conductor of the impulse generated by the pulse generator to the myocardium. It has an insulated (non-conductive) cover and can be of uni- or bipolar types, each having their own specific advantages and disadvantages.
Complications due to implantation of pacemakers can be divided into three groups:

a) Complications due to subclavian vein entry:
1- Pneumothorax
2- Entry to subclavian artery
3- Air embolism
4- Nerve injury
5- Thoracic outlet injury
6- Vein thrombosis
7- Superior vena caval obstruction
8- Hemothorax

b) Complications due to lead or pulse generator implantation:
1- Myocardial perforation.
2- Right diaphragm stimulation by right atrial electrode.
3- Pectoral muscle stimulation because of insulation fracture or without fracture in unipolar leads.
4- Twiddler syndrome.
5- Infection of implantation site (early or late).
6- Lead fracture or faulty insulation.

Listed below are some complications due to deficient pacemaker functioning :
1- Loss of myocardial capture that can be due to the following:
- Pulse generator failure, such as battery depletion.
- Lead failure, such as fracture.
- Failure of electrode contact with myocardial site, increase in stimulation threshold.
2- Pacemaker sensing failure that can take the following forms:
- Undersensing which is commonly due to low amplitude electrocardiogram.
- Oversensing which is the most common cause of pause in pacemaker functioning and may be due to myopotential sensing of skeletal muscle potentials.

Permanent pacemakers are coded according to the differing capabilities that each one possesses. Almost all pacemakers utilized today are equipped with telemetry which allows one-way transmission of data from pulse generator to an external receiver and two-way transmission of instructions from a programming device to a pulse generator. This capability also provides an option for non-invasive permanent or temporary programming of the device. The first modern programming device introduced in 1972 was only capable of programming some of the parameters. However, today some dual chamber pacemakers can accept 2.5×10^{23} programming variations from the programmer. On the other hand, as has already been mentioned, differing complications can affect and endanger the correct functioning of permanent pacemakers. These can be avoided or treated if correct preventative procedures are followed and regular examination of patients at specialized centers are carried out, allowing early diagnosis and possible treatment by using non-invasive procedures.

Undersensing is a common pacemaker disorder. Its most common cause is low amplitude electrocardiogram, followed by lead displacement, low amplitude signals due to a premature ventricular complex and myocardial infarction. This disorder is predominantly treated by determining the sensing threshold and reprogramming the pacemaker.

In Griffin's statistics resulting from a one-year research period, undersensing was responsible for 57% of pacemaker disorders and lack of myocardial capture was observed in

18% of cases. Today it is possible to register the electrocardiogram of permanent pacemaker patients over the telephone line. Such facilities for the patient should be provided such that at times when required, like when there is a likelihood of heart arrhythmia, they would be able to transmit their electrocardiogram to the central device and at times when it is impossible for them to attend the pacemaker clinic at appointed times, an early diagnosis of battery life termination could be made.

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