LONG TERM FOLLOW-UP OF THE PACED PATIENTS

By Motokazu Hori

I. PHILOSOPHY OF AFTERCARE OF THE PATIENTS WITH IMPLANTED PACEMAKERS[1,2]

Treatment of brady—or tachyarrhythmias by pacing does not finish but does begin at the time of patients' discharge from the hospital. None of the patients can be free of aftercare, because the pacing treatment is only a symptomatic measure but not a radical one for the underlying heart diseases. Even if the patients could be relieved from fears of Adams-Stokes attacks, cardiac failure or sudden rhythm death by cardiac pacing, a continuous care should be paid on the underlying diseases. The indication of rehabilitation to the patients should be the most adequate to their cardiac reserve function at the given heart rates throughout the patients' lives.

None of the implanted pacemakers can assure an unlimited longevity and anticipate no premature failure, though electronic engineering has progressed markedly in recent years. From the technological viewpoint, it is the most important follow-up management to obtain the maximum useful life from the implanted units and to replace the failing units electively before failed.

II. AFTERCARE ROUTINE

Long-term pacing can let most but not all of the patients return to work and to society. Therefore, aftercare has to be continued not only at the hospital but also at home or work place of the patients. Routine life should be cared by the patients themselves and sometimes by their families.

Arrhythmias, congestive heart failure and anginal pain are the subjects for strict attention. Heart rate and rhythm should be regularly recorded at their home. Education for the patients and their families is needed for those purposes.

III. CARE OF COMPLICATIONS

Many of the postimplantation complications are followed by the inadequate indication, choice of pacemakers and procedure for implantation and can be prevented by a careful management. Infection or decubital ulcer of skin at the implanted site is the simplest one of this category. Displacement, dislodgement or malposition of the electrode is one of the complications specific to the endocardial electrode system as well as ventricular perforation or thromboembolism.

Besides other complications including threshold elevation, the physical and psychological maladaptation to pacing is a new iatrogenic complication of "pacemaker syndrome".[3] If the new heart rate (or pacing rate) is set with little attention to the patient's optimal heart rate as well as mental influences before and at implantation, he is apt to suffer from this complication, of which complaints are shortness of breath, exertional dyspnoea, palpitation, anginal pain, flushing face and/or psychological distress.[4]

The "pacemaker syndrome" may be due to discrepancy between the patient's optimal heart rate and pacemaker rate. Sudden and very effective change of his heart rate will sometimes result in this type of maladaptation syndrome. This is rather often seen in the elderly patients with coronary sclerosis or in those who are psychologically unstable.

Professor of Surgical Science Heart Institute, Japan and Tokyo Women's Medical College.

Even if a given pacing rate might be thought theoretically optimal, it could not be so unless the patient could feel comfortable and optimal by himself.

IV. TESTING ROUTINE AND FOLLOW-UP METHODS

It is often necessary for follow-up of the paced patients to be carried out in a special unit, the pacemaker clinic, where skilled physician and engineers and sophisticated facilities can be assembled. At each scheduled visit of the patient to the clinic, the following examinations are obtained:[2,5] (1) routine physical examinations, (2) a standard six and chest leads electrocardiography with a long rhythm strip in the lead showing the pacer spikes, QRS and P waves most clearly and concurrently, (3) when arrhythmia is found, a careful analysis whether or not it is reasonable,[6] (4) the proof of normal sensing and pacing function in triggered pacemaker, including an evaluation of pacemaker dependence and e'ectrocardiography of underlying rhythm and QRST,[7,8] (5) the base pacemaker rate or the average interval between pulses, (6) an oscilloscopic picture of the pacemaker pulse[5,9] recorded on a Polaroid film displaying output amplitude, width and shape of the pulse wave, and (7) x-rays of the pulse generator and electrode and lead.

Standard electrocardiography is incapable of providing critical and predictable information but capable of obtaining information of overall function of the implanted unit and diagnosing arrhythmia during pacing. Complicated myocardial infarction during the ventricular pacing is hard to diagnose without clinical and enzyme findings as well as electrocardiography of undistored underlying rhythm and QRST.[7,8]

Most pacemakers now manufactured and implanted have a battery output related change in rate. Therefore, rate counting or measurement of a pulse-to-pulse interval is simple but one of the most reliable parameters to assess battery depletion.

Failure to triggered function may mean loss of sensing threshold due either to a change in electrode position, battery depletion or circuit electronic malfunction.

Electronic photoanalysis of the pacemaker pulse is characteristic of the pulse generator output and modified by both electrodes, changes in myocardial and peripheral lead impedance and by respiration.[5] Because amplitude is low and easily apt to change due to electrical dipole shift within the heart, it is less reliable in the bipolar electrode system, while it is a reliable index of output voltage in the unipolar system. Stimulus amplitude is better analyzed at least as the formal plane vector[10] and preferably as the X-Y-Z vector.[11] Changes in pulse width and contour have a less diagnostic value.[15]

X-ray analysis of the batteries is only grossly approximate to evaluate output decay, whereas that of the electrode and lead system is frequently helpful to diagnose fault of the system.

V. PACEMAKER CLINIC VIA TELEPHONE[12]

Transmission of the informations on implanted pacemaker from the patient to the clinic via a conventional telephone line may be added to the pacemaker clinic follow-up for the frequent data acquisition and to avoid emergency without the patient's visit. In case that the regular check-up is not sufficient in, for example, emergency pacing failure, this system and 24-hour services using telephone and computer will be very effective.[5]

It is now possible to transmit not only rate but also stimulus pulse information by telephone line to any distant places.[13]

VI. STANDARD CRITERIA TO REPLACE PULSE GENERATOR [13, 14]

No one change in many parameters can be an absolute reason for the replacement of failing pulse generator unless it is major. In general, the combination of changes is considered before the replacement is scheduled.

The following changes are our standard criteria: (1) pacing failure or runaway due to the pulse generator, (2) failure of the triggered or synchronous function, (3) rate change more than $\pm$ 10% of the original base rate, (4) more than 40% drop in amplitude, more than 20% change in width and changes in shape of the pulse wave on photoanalysis, (5) more than 40% decrease in output energy as calculated by vector^2 x pulse width x rate, and (6) after the manufacturer's recommended time of replacement.

All the pacemakers should be designed based on a simple, accurate and reliable correlation between battery depletion, component failure and changes of parameters to be checked.[15, 16]

VII. RESULTS OF FOLLOW-UP OF THE PACED PATIENTS

Long-term results of the cardiac pacing with implanted units are quite satisfactory, significantly preventing sudden death and cardiac failure, relieving complants and symptoms and extending survival. Furthermore, the satisfactory aftercare of the paced patients and follow-up management of the implanted pacemakers are contributing in improving the long-term results.

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