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Clinical Analysis of 110 Postoperative Deaths of the Patients with Permanent Implantable Pacemaker

Yuichiro MATSUURA, Hiroshi ISHIHARA, Yoshiharu HAMANAKA, Taijiro SUEDA, Yoshio OHNO, Hideki YAMASHINA*, Masanori HIGO*, Takanori FUJII* and Masaharu YAMAMOTO*

The 1st Department of Surgery, Hiroshima University School of Medicine, Hiroshima 734, Japan

* *Department of Thoracic & Cardiovascular Surgery, Hiroshima Prefectural Hospital, Hiroshima 734, Japan*

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ABSTRACT

During 14 years follow up of 754 patients received permanent cardiac pacemaker (PM) implantation, 110 cases have died. In this paper, the cause of death of them was clinically analyzed. The death to senility was most frequent, in 31 cases out of 110 deaths (28.2%), and then heart failure in 19 cases (17.3%), cerebrovascular disease in 16 cases (14.5%), sudden death in 14 cases (12.7%), malignancy in 7 cases (6.4%), acute myocardial infarction in 7 cases (6.4%), severe infectious disease in 4 cases (3.6%), unknown etiology in 4 cases (3.6%), renal failure and Disseminated Intravascular Coagulation Syndrome (DIC) in 2 cases (1.8%), respectively, suicide in one case (0.9%).

Cause of death by underlying disease was rather characteristic. Senility was frequent in the patients with atrioventricular (A-V) block (38.5%), while cerebrovascular disease was highly observed in the patients with Sick Sinus Syndrome (SSS) (28.1%), and heart failure was highly observed in the patients with atrial fibrillation (46.2%). Senility was seen in 44.8% of the patients with coronary arteriosclerosis, cardiac death in 85.7% of the patients with cardiomyopathy, and in 100.0% of the cases with valvular disease.

The above mentioned fact suggests that cardiovascular check up is most important in postoperative follow up of the patients with PM. In old cases, senility and infection were major cause of death, so guidance concerning to dietary life and periodical health examination against wasting disease is important especially in this group. And, active care for heart failure is also more important in the patients with cardiomyopathy and valvular disease.

Recently PM implantation has been increasing. Since its indication was enlarged with its mechanical development and improvement, long term paced patients were increased and they are living as well as healthy persons.

However the authors have observed 110 deaths during 14 years follow up of 754 patients with permanent PM. In this paper, the causes of death of the patients with PM were clinically analyzed to get some ideas for the follow up of the patients with PM.

SUBJECTS AND METHODS

PM was implanted in 754 patients with symptomatic bradycardias from 1972 through 1985 at Hiroshima University Hospital and Hiroshima Prefectural Hospital.

The subjects of this study were 110 deaths

among them.

The causes of death were analyzed by age and sex distribution, preoperative ECG findings, underlying disease or duration between PM insertion and death.

The cause of death was obtained from history record at admitted hospital, or report from home doctor or family who was noticed the cause of death by their home doctor. Statistical observation was made by χ^2-test.

RESULTS

Age and sex distribution of the subjects is shown in Table 1. The rate of death below 60 years of age was 5.3—9.7%, while that above 60 years of age was 25.9% in male and 21.0% in female, respectively. The cause of death was variable and that due to senility was most frequent, namely in 31 cases, and then heart failure in 19 cases, cerebrovascular disease in 13 cases, sudden death in 14 cases, malignancy in 7 cases, acute myocardial infarction in 7 cases, severe infectious disease such as pneumonia in 4 cases, Disseminated Intravascular Coagulation Syndrome (DIC) in 2 cases, one suicide, one PM trouble and 4 cases with unknown etiology.

The causes of death were more characteristic by age (Table 2), and that due to heart failure or sudden death was significantly frequent, 13 cases out of 16 patients (81.3%) in the group of age below 50 years compared with the older age group; 27 cases out of 94 patients ($p<0.01$), and that due to cerebrovascular disease was rather few, only one case out of 16 patients (6.3%) in this group. Cardiac death in the group of age of 61—70 years was seen in 11 cases out of 29 patients (37.9%), while death due to cerebrovascular disease was rather frequent, 8 cases out of 29 patients (27.5%) compared with the group

Table 1. Age and sex distribution of death in the patients with permanent pacemaker

Sex / Age	Male		Female		Total	
	No. of Patient	No. of Death (%)	No. of Patient	No. of Death (%)	No. of Patient	No. of Death (%)
—40	14	1 (7.1)	19	1 (5.3)	33	2 (6.1)
41—50	31	3 (9.7)	26	2 (7.7)	57	5 (8.8)
51—60	53	5 (9.4)	69	4 (5.8)	122	9 (7.4)
61—70	98	18 (18.4)	106	11 (10.4)	204	29 (14.2)
71—80	137	26 (20.0)	101	18 (17.3)	238	44 (18.5)
81—	54	14 (25.9)	46	7 (15.2)	100	21 (21.0)
Total	387	67 (17.3)	367	43 (11.7)	754	110 (14.6)

Table 2. Cause of death in the patient with PM according to age

Cause of death / Age	—40	41—50	51—60	61—70	71—80	81—	Total
Cerebral hemorrhage			1 (11.1)	1 (3.4)	2 (4.5)		4
Thromboembolism of the brain				7 (24.1)	4 (9.1)	1 (4.8)	12
Heart failure	1 (50.0)		3 (33.3)	6 (20.7)	9 (20.5)		19
Sudden death		5 (100.0)	3 (33.3)	3 (10.3)	2 (4.5)	1 (4.8)	14
Acute myocardial infarction			1 (11.1)	2 (6.9)	4 (9.1)		7
Rupture of Aortic aneurysm						1 (4.8)	1
Renal failure	1 (50.0)				1 (2.3)	1 (4.8)	3
Senility				4 (13.8)	14 (31.8)	13 (61.9)	31
Malignancy			1 (11.1)	2 (6.9)	3 (6.8)	1 (4.8)	7
Infectious disease				2 (6.9)	1 (2.3)	1 (4.8)	4
DIC				2 (6.9)			2
Suicide					1 (2.3)		1
PM trouble				1 (3.4)			1
Unknown					2 (4.5)	2 (9.5)	4
Total	2	5	9	29	44	21	110

DIC: Disseminated Intravascular Coagulation Syndrome

of age below 60 years. In the group of age of 71—80 years, cardiac death was 15 cases out of 44 patients (34.1%) and death due to senility was 14 cases (31.8%), that is, death due to senility increased significantly in this group compared with the younger group ($p<0.01$).

Death due to senility was also significantly frequent in the old aged group ($p<0.01$), especially in the group of age above 81 years, 61.9%, compared with the young age group, 13.8—31.8% ($p<0.01$).

The cause of death by sex is shown in Table 3. The cause of death by sex was characteristic and death due to cerebrovascular disease was seen in 9 cases out of 43 patients in female (20.9%), while that due to cerebrovascular disease was rather few in male, namely 7 cases out of 67 patients (10.4%). Cardiac death was 27 cases out of 67 patients (40.3%) in male while 13 cases out of 43 patients (30.2%) in female.

Table 3. Cause of death in our series according to sex

Cause of death \ Sex	Male	Female	Total
Cerebral hemorrhage	1 (1.5)	3 (7.0)	4
Thromboembolism of the brain	6 (9.0)	6 (14.0)	12
Heart failure	13 (19.4)	6 (14.0)	19
Sudden death	10 (14.9)	4 (9.3)	14
Acute myocardial infarction	4 (6.0)	3 (7.0)	7
Rupture of aortic aneurysm	1 (1.5)		1
Renal failure	2 (3.0)	1 (2.3)	3
Senility	19 (28.4)	12 (27.9)	31
Malignancy	4 (6.0)	3 (7.0)	7
Infectious disease	3 (4.5)	1 (2.3)	4
DIC		2 (4.7)	2
Suicide		1 (2.3)	1
PM trouble	1 (1.5)		1
Unknown	3 (4.5)	1 (2.3)	4
Total	67	43	110

DIC: Disseminated Intravascular Coagulation Syndrome

Table 4. Cause of death in our series according to electrocardiographic finding (ECG)

Cause of death \ ECG	A-V block	SSS I	SSS II	SSS III	Af	Total
Cerebral hemorrhage	2 (3.8)		1 (6.7)	1 (7.1)		4
Thromboembolism of the brain	3 (5.8)		4 (26.7)	3 (21.4)	2 (7.7)	12
Heart failure	4 (7.7)		3 (20.0)		12 (46.2)	19
Sudden death	7 (13.5)	1 (33.3)	1 (6.7)	1 (7.1)	4 (15.4)	14
Acute myocardial infarction	1 (1.9)		3 (20.0)	2 (14.3)	1 (3.8)	7
Rupture of aortic aneurysm		1 (33.3)				1
Renal failure	3 (5.8)					3
Senility	20 (38.5)		2 (13.3)	5 (35.7)	4 (15.4)	31
Malignancy	5 (9.6)			1 (7.1)	1 (3.8)	7
Infectious disease	2 (3.8)	1 (33.3)			1 (3.8)	4
DIC	1 (1.9)				1 (3.8)	2
Suicide	1 (1.9)					1
PM trouble	1 (1.9)					1
Unknown	2 (3.8)		1 (6.7)	1 (7.1)		4
Total	52	3	15	14	26	110

DIC: Disseminated Intravascular Coagulation Syndrome

The cause of death according to preoperative ECG findings are shown in Table 4. Among the patients with A-V block, death due to senility was most frequent (38.5%) and significantly higher rate compared with other groups ($p<0.05$), while among SSS, deaths due to cerebrovascular disease, 7 cases of cerebral embolism and 2 cases of cerebral hemorrhage, were most frequent, 28.1%, compared to the other group ($p<0.025$), and among atrial fibrillation heart failure was most frequent in 12 cases out of 25 patients (48.0%), compared to the other group ($p<0.01$).

The underlying disease of the subjects is shown in Table 5. In the patients with arteriosclerosis, senility was most frequent cause of death and significantly frequent in 20 cases out of 58 patients (40.0%) ($p<0.01$), while in the patients with cardiomyopathy cardiac death was more frequent, namely heart failure in 8 cases

Table 5. Cause of death in our series according to underlying disease

Cause of death \ Underlying disease	Arterio-sclerosis	Myocardial infarction	Cardio-myopathy	Valvular lesion	Cerebrovas-cular disease	Unknown	Total
Cerebral hemorrhage	2 (3.4)				1 (33.3)	1 (3.7)	4
Thromboembolism of the brain	5 (8.6)		1 (7.1)		1 (33.3)	5 (18.5)	12
Heart failure	4 (6.9)		8 (57.1)	4 (80.0)		3 (11.1)	19
Sudden death	3 (5.2)	1 (33.3)	4 (28.6)	1 (20.0)		5 (18.5)	14
Acute myocardial infarction	3 (5.2)					4 (14.8)	7
Rupture of aortic aneurysm	1 (1.7)						1
Renal failure	2 (3.4)					1 (3.7)	3
Senility	26 (44.8)	2 (66.7)			1 (33.3)	2 (7.4)	31
Malignancy	4 (6.9)					3 (11.1)	7
Infectious disease	2 (3.4)					2 (7.4)	4
DIC			1 (7.1)			1 (3.7)	2
Suicide	1 (1.7)						1
PM trouble	1 (1.7)						1
Unknown	4 (6.9)						4
Total	58	3	14	5	3	27	110

DIC: Disseminated Intravascular Coagulation Syndrome

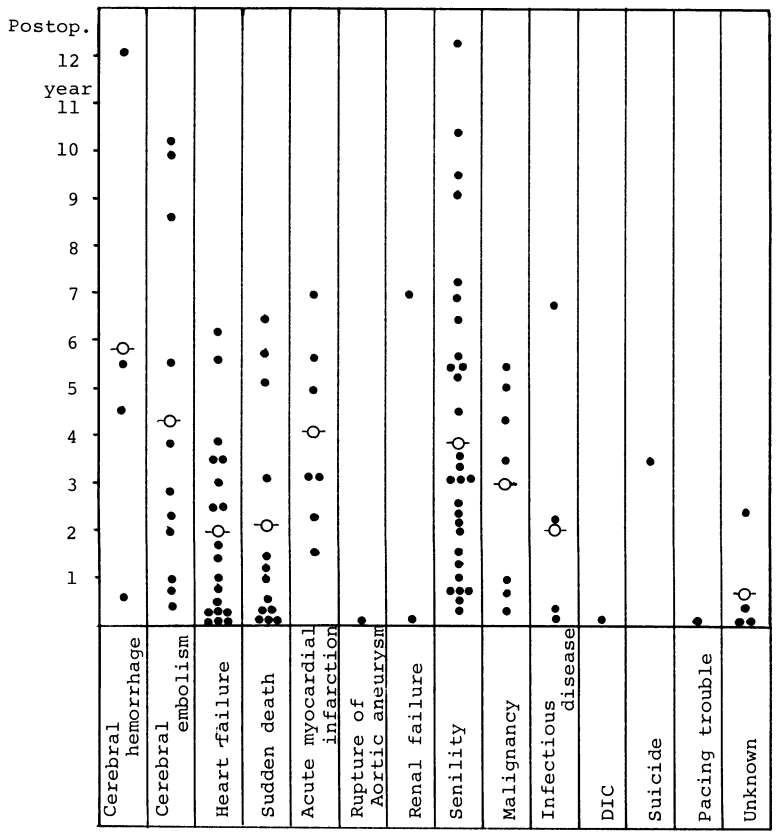

Fig. 1. Duration between the time of permanent pacemaker implantation and death. DIC: Disseminated Intravascular Coagulation Syndrome

and sudden death in 4 cases out of 14 patients (85.7%) ($p<0.01$). All of valvular diseases were died of heart diseases, while the patients with bradycardia due to cerebrovascular disease were died of recurrence of it or another new cerebrovascular disease in 2 cases out of 3 patients. In the group of unknown etiology, death due to heart disease such as heart failure or sudden death was seen in 12 cases out of 27 patients (44.4%) and cerebrovascular disease in 6 cases (22.2%).

Postoperative follow up duration of the patients with PM according to the cause of death is shown in Fig. 1. The duration was distributed from within one year to 12 years. The 39 patients have died within one year. Mean postoperative duration of those died of cerebral hemorrhage was 5 years and 8 months, and that of cerebral embolism was 4 years and 3 months, while that of heart failure or sudden death was within 2 years, and that of senility was 3 years and 9 months.

DISCUSSION

It has been commonly believed that prognosis of the patients with PM was not bad and almost of them could enjoy their everyday living as well as the healthy persons in the postoperative stable stage[23]. In 1985, the authors[16] studied on the prognosis of 316 patients with permanent PM and reported that 6-year survival rate was calculated as 81.9% in the patients with A-V block, 100% in those with SSS I, 80.0% in those with SSS II, 65% in those with SSS III and 37.0% in those with atrial fibrillation. And the authors also described that prognosis of the patient with cardiomyopathy and/or valvular disease as the underlying disease of bradycardia was not good compared to the other groups, while the cause of death in that series was not analyzed in detail.

Recently the number of the patient with PM increased and death of them increased in number as a natural course of that event, so the analysis of their cause of death was carried out to find out the practical guide for the follow up of them in this paper. In 1972, Green and his associates[6] informed that they experienced 22 death among 127 patients with PM during 4 years follow up. On the other hand, in Japan, 19 death out of 76 patients with PM was observed by Tsuruha and his associates[22], 7 death out of 48 patients with PM by Fukatani and his associates[2], 30 death among 114 patients with PM by Kato and his associates[12], 24 death out of 252 patients with PM by Ikeda and his associates[11], 20 death out of 114 patients with PM by Hamada and his associates[7], 12 death out of 173 patients with PM by Morimoto and his associates[18] and 22 death out of 107 patients with PM by Yamagata and his associates[24]. In our series of 754 patients, 110 cases were died during 14 years follow up.

The causes of death of the patients with PM which were reported in the literatures were summerized in Table 6. It was peculiar in our series that main cause of death was senility.

This finding might be due to the situation that the cause of death in the most of cases was decided by their home doctor. The rate of cardiac death was 16.7–60.0% (mean 34.9%) and then cardiac disease was regarded being main cause of death, so it might be said follow up of the patients with PM should be aimed at the cardiovascular system first of all. Hasegawa and his associates[9] demonstrated that the patients with PM showing an increase in TPR and a decrease in ET/PEP had a high incidence of death due to heart disease and described that measurement of TPR and ET/PEP was important as the follow up procedure for the patient with PM. Among cardiac death in the patients with PM, heart failure was main cause and its rate was 16.7–63.6% (mean 34.7%) and the rate of sudden death was calculated 5.3–38.9% (mean 33.7%). It is suspected that actual cause of sudden death was related to fatal arrhythmia, and, therefore, 24-hr Holter study is recommended in the patients who were intending to return to his daily life after PM implantation. On the other hand, the rate of death from cerebrovascular disease was calculated 0–42.1% (mean 12.6%) and that from malignancy was 0–30.0% (mean 10.7%). So care of the cerebrovascular system and test for malignancy should be added in the follow up procedure.

In 1974, Siddons and his associates[21] presented that 13 cases out of 145 patients were died of PM trouble, and in 1975 in Japan, Kawakami and his associates[3] reported 6 deaths from PM generator failure and one death from right ventricular rupture by endocardial lead. Even-

Table 6. Cause of death in the patient with permanent pacemaker which were reported in the literatures.

Cause of death \ Author	Gadboys[5] (1968)	Harris[8] (1968)	Kawakami[13] (1975)	Tsuruha[22] (1977)	Fukatani[2] (1978)	Fuse[3] (1978)	Fitzgerald[1] (1979)	Kato[12] (1979)	Ikeda[11] (1979)	Hamada[7] (1979)	Morimoto[18] (1983)	Yamagata[24] (1986)	The authors (1986)
Cerebrovascular disease	2		1	8	2			4	3	3	2	6	16
Heart failure				2		13		3	6		1	6	19
Sudden death	8	8		1		3	37	7	4	5	1	3	14
Acute myocardial infarction			2	1		2		1			1		7
Rupture of aortic aneurysm													1
Embolism of the aorta		1											
Pulmonary disease	6												
Gastrointestinal disease	4									2	1		
Hepatic disease					1				1		1		
Renal failure	2										1		3
Senility										2			31
Malignancy	2	1	2	5	1		5	1	5	6	1	5	7
Infectious disease		2		2	1			1	5	1	1	2	4
DIC													2
Suicide											1		1
Miscellaneous	5	9				6							
Pacemaker trouble	6	3	7			6	5						1
Unknown	1	2			2			1		1			4
Total of death	36	26	12	19	7	30	46	18	24	20	12	22	110
Total of patient			52	76	48	114		103	252	114	173	107	754

DIC: Disseminated Intravascular Coagulation Syndrome

though it was supposed that the incidence of PM trouble was higher in the early years of PM development compared with nowaday when PM construction and function is strikingly improved.

Miyawaki and his associates[17] still, in 1980, reported that 10 cases out of 55 deaths was due to PM trouble. From this fact, 24-hr Holter study as mentioned above is also essential to check if PM functions well even in the recent patients. In the type of endocardial pacing, the foreign body, namely, endocardial leads are inserted in the cardiac cavity, so any infection in relation to PM may progress fatal occasionally.

Ohishi and his associates[20] described that they experienced 6 deaths out of 50 patients with PM one of whom was suffered from brain abscess following to wound infection of PM insertion. In our series, there was not found any sign and symptom of infection concerning to PM insertion in the acute phase. The authors supposed that active chemotherapy using two types of antibiotics for postoperative 5–7 days was main reason for the postoperative cause free from remarkable infection. While the authors experienced 4 cases of infection around the PM pocket of unknown origin during long term follow up, and replacement of PM generator was successfully performed using together with active adequate chemotherapy. According to Table 6, there were 2 cases of suicide. This fact suggests us that psychological care is also important in the patient with PM.

It has been payed attention that the incidence of cerebral embolism was relatively high in the patients with PM, so the authors[16] investigated the possibility of thromboembolism in the right side heart, namely the occurrence of pulmonary embolism by lung perfusion scanning. It was disclosed that a defect of lung perfusion in the scanning was seen by 34% of the subjects, and the time of its occurrence inclined toward the postoperative early phase. Moreover, Kinney and his associates[14] presented a report of recurrent pulmonary emboli secondary to right atrial thrombus around a permanent pacing catheter.

From these matters, it may be said that some preventive means against pulmonary embolism

should be taken at the time of PM implantation.

Hetzel and his associates[10] described that the patients with PM and ischemic heart disease took poorer prognosis than the other, and Ginks and his associates[4] informed that the patient with PM and a history of myocardial infarction took poor prognosis.

From statistics of survival rate in 1981[15], 7-year survival rate of the PM patient of bradycardia of unknown etiology was 95.5%, that of old myocardial infarction 89%, that of other ischemic heart disease 83.3%. This statistics also indicated that coexistence of ischemic heart disease in the patients with PM deteriorated their prognosis.

Nishimoto and his associates[19] experienced 18 deaths in the paced patients with A-V block and 8 deaths in that with SSS, and said that the incidence of sudden death was high in the patients with A-V block and that of cerebral thromboembolism was high in the patients with SSS.

In our series, most common cause of death in the paced patients with A-V block was senility and secondary sudden death, and that of the paced patients with SSS II was cerebrovascular disease. This findings suggest that different type of follow up should be scheduled in the paced patients with A-V block and SSS.

Yamagata and his Associates[24] informed that pneumonia, heart failure and wasting disease were relatively frequent as the cause of hospital death in the old age. It is to say that senility and the presence of wasting disease is one of the weighing factors influencing the prognosis, and guidance concerning to dietary life and periodical health examination especially against wasting disease is very important in the old patient.

At all events, now, as mentioned above the five major causes of death are senility, cardiac disease, cerebrovascular disease, malignancy and infectious disease in the patients with PM, while this precedence might be changed with advance of medical science in the future as seen in the past statistics of cause of death in Japan presented by the Welfare Ministry.

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