

Use of temporary cardiac pacing, its complications and need for permanent cardiac pacing

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Acronyms

ACS: acute coronary syndrome

AMI: acute myocardial infarction

AV block: atrioventricular block

CPA: cardiopulmonary arrest

PM: pacemakers

PPM: permanent PM

TPM: temporary PM

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ABSTRACT

Introduction: Temporary cardiac pacing is used in various extreme emergency situations, in patients with severe bradyarrhythmias and second and third degree atrioventricular block. Its use is always considered when there are symptoms such as a significant hemodynamic compromise, not responding to medication, and little tolerance to slow pace.

Objective: To describe the main use of temporary cardiac pacing that may lead to permanent pacing, and the complications that arise when using it.

Method: A descriptive study was conducted in 266 of the 281 patients who were admitted to the Arnaldo Milián Castro Hospital and received a temporary pacemaker. The use and complications of the procedure are described.

Results: There was a higher use of temporary cardiac pacing as the age of the study population increased, 45.86% for those over 80 years of age. Females predominated (156 patients), with a female-male ratio of 1.56:1. The degenerative cause (42.1%) was the major cause for permanent pacing. The puncture of unwanted vessels was the most common complication (7.1%).

Conclusions: The use of temporary cardiac pacing is more common in people over 80 years of age, mainly because of degenerative causes, which eventually leads to permanent pacing. The complication rate is not high considering that this procedure was not performed under fluoroscopic view.

Key words: Pacing, Artificial cardiac pacing, Artificial pacemaker

Indicaciones de estimulación eléctrica transitoria, complicaciones y necesidad de estimulación cardíaca permanente

RESUMEN

Introducción: La estimulación cardíaca temporal está indicada en diversas situaciones de extrema urgencia, en pacientes con bradiarritmias graves y bloqueos aurículo-

ventriculares de II o III grados. Su indicación siempre se considera ante la presencia de síntomas como: compromiso hemodinámico importante, que no responde a los medicamentos, y poca tolerancia al ritmo lento.

Objetivo: Describir las principales indicaciones de estimulación eléctrica transitoria que pueden llevar a la estimulación eléctrica permanente, así como las complicaciones que se presentan al utilizarla.

Método: Se realizó un estudio descriptivo donde se estudiaron 266 pacientes de 281 ingresados en el Hospital "Arnaldo Milián Castro", a los cuales se les implantó un marcapasos transitorio. Se describen las indicaciones y complicaciones del procedimiento.

Resultados: Se observó un mayor número de indicaciones de estimulación eléctrica transitoria cuando aumenta la edad de la población en estudio, 45,86 % para los mayores de 80 años. El sexo femenino predominó (156 pacientes), con una relación mujer-hombre de 1,56:1. La causa degenerativa (42,1 %) fue la mayor indicación de estimulación eléctrica permanente. La punción de vasos no deseados fue la complicación más frecuente (7,1 %).

Conclusiones: La indicación de estimulación eléctrica transitoria es más frecuente en los mayores de 80 años, principalmente por causa degenerativa, que finalmente lleva a la estimulación eléctrica permanente. El porcentaje de complicaciones no se muestra elevado cuando se tiene en cuenta que este procedimiento no se realizó bajo visión fluoroscópica.

Palabras clave: Estimulación eléctrica, Estimulación cardíaca artificial, Marcapaso artificial

INTRODUCTION

Heart pacemakers (PM) have been used in the treatment of bradyarrhythmias for over 50 years¹. In 1899, JA McWilliam could create electrical impulses in asystolic human hearts and caused ventricular contractions between 60-70 beats per minute. Ake Senning implanted the first PM to Arne H. W. Larsson in Sweden in 1958. That same year, Furman and Schewedel performed the first transvenous implantation. Some years later, in 1972, M. Mirowsky carried out the same procedure².

There are different types of temporary cardiac pacing (transcutaneous, transesophageal, transvenous and epicardial temporary pacing). The most used type is that which is carried out through a peripheral venipuncture and placement of an electrode in the right cavities (transvenous pacing)³.

Temporary cardiac pacing is used in various extreme emergency situations, in patients with severe bradyarrhythmias and second and third degree atrioventricular block (AV block). Its use is always considered when there are symptoms such as a significant hemodynamic compromise, not responding to medication, and little tolerance to slow pace^{1,4}.

Its use in acute myocardial infarction (AMI) deserves special attention, since the risk-benefit ratio is not well

defined in these cases, because death, in general, is not related to the conduction disorder but to the size of the infarction; however, it is known to reduce the risk of death due to arrhythmias^{2,5}.

There are very few contraindications to the use of temporary PM (TPM). Hypothermia is among them, which may cause bradycardia as a physiological response; in addition, ventricles are more susceptible to fibrillation. Bradycardia in children generally results from hypoxia or hypoventilation, and usually responds very well to other treatments^{1,5-7}.

Among the major complications in patients with temporary PM implantation are those that occur during placement of the electrode lead. These may be local complications, such as difficulties with venous access, in venous dissection, arterial puncture, the occurrence of pneumothorax-hemopneumothorax, lesions in nerve structures, air embolism and subcutaneous emphysema^{2,6,7}.

Cardiac complications have also been described, for example, arrhythmias, heart failure, perforation of the septum and free wall, and rupture of the tricuspid and papillary muscles^{4,7}.

In days following implantation, septic complications may occur at the puncture site, and sepsis at other levels (neck, chest, deep thrombophlebitis, infective

endocarditis, pericarditis, and myocarditis). Non-septic complications may also occur, including hematomas, upper limb edema, stimulation (muscle, skeletal or diaphragmatic stimulation) and electrode displacement⁸⁻¹⁰.

Due to the progressive aging of the population, the incidence of atrioventricular block is higher; therefore, a greater number of temporary and permanent PM is required¹¹.

Temporary transvenous cardiac pacing is a widely used technique that may save the life of a critically ill patient; and it is the only therapeutic option that can maintain a right, stable pace, in a painless and prolonged way, in patients with asystole or extreme bradycardia. Its extraordinary utility makes us forget that it is an invasive technique which requires a minimal infrastructure, basic knowledge, operator's experience, and adequate monitoring of the patient during and after the procedure. The aim of this study was to describe the main uses of temporary cardiac pacing which may ultimately lead to permanent pacing, and the complications that may arise when using it.

METHOD

An observational, descriptive and prospective study was conducted at the Cardiology Department of the Arnaldo Milian Castro Provincial University Hospital in Santa Clara from May 2009 to May 2011.

The study population consisted of 281 patients, who required the implantation of a temporary PM and were admitted to the cardiology department of the above mentioned hospital during that period. The sample consisted of 266 patients who were chosen through a non-random, intentional selection.

Inclusion criteria:

- All patients who underwent temporary PM implantation.

Exclusion criteria:

- Those patients whose evolution was not monitored until discharge because they were transferred to other services.

The age and the causes of temporary PM implantation were taken into consideration when grouping the patients. The causes included AV block of degenerative cause, mediated by medications; cardiopulmonary arrest (CPA) in asystole, ischemic causes and failures in previously implanted permanent PM. The time of temporary pacing was taken into account, as well as the causes for the use of temporary PM. The need for implantation of a permanent PM was assessed.

The complications due to temporary PM implantation were grouped together as follows: unwanted vessel puncture, electrode displacement with pacing failure, arrhythmias, hematomas and pneumothorax.

RESULTS

The number of patients who needed TPM increased with increasing age (Table 1), 122 of them were 80 years or older, representing the largest percentage in the study group (45.86%). Those patients aged 70 – 79 years were second, accounting for 34.59% of the total. The overall mean age of the patients who underwent TPM implantation was 77.63 years, with a standard deviation of 7.64 years.

With regard to sex, there was a significant predominance of females ($p = 0.0000$), with 162 patients (60.90%) and a rate of approximately 1.56 women per man. The average age for each sex was similar, around 77 years of age ($p = 0.3762$).

The time of temporary pacing and the causes for

Table 1. Patients with temporary pacemaker implantation, by age and sex.

Age	Male		Female		Total	
	Nº	%	Nº	%	Nº	%
60 a 69 years	22	8,27	30	11,28	52	19,55
70 a 79 years	38	14,29	54	20,30	92	34,59
80 years and over	44	16,54	78	29,32	122	45,86
Total	104	39,10	162	60,90	266	100

$$X^2 = 0.8842 \quad p = 0.6427$$

Women index: 155.77 per 100 men.

Group mean age: 77.63 years

Standard deviation: 7.64 years

Male mean age: 77.11 years

Standard deviation: 7.68 years

Female mean age: 77.96 years

Standard deviation: 7.60 years

$$T = 0.8864 \quad p = 0.3762$$

$$Z = 4.9425 \quad p = 0.0000$$

Table 2. Distribution of causes for temporary pacemaker implantation, according to the time of pacing.

Causes for the use of PM	Time of pacing						Total	%
	Less than 72 hours		From 72 hours to 7 days		More than 7 days			
	Nº	%	Nº	%	Nº	%		
Degenerative	59	22,2	54	20,3	4	1,5	117	44,0
Ischemic	6	2,3	18	6,8	48	18,0	72	27,1
Drugs	5	1,9	16	6,0	44	16,5	65	24,4
CPA in asystole	7	2,6	1	0,4	1	0,4	9	3,4
Failure in pacing	3	1,1	0	0	0	0	3	1,1
Total	80	30,1	89	33,5	97	36,5	266	100,0

$X^2=132,899$ $p = 0.002$

Table 3. Distribution of causes for temporary pacemaker implantation, according to the need for PPM implantation.

Causes for the use of TPM	Need for permanent PM				Total	
	Yes		No		Nº	%
	Nº	%	Nº	%		
Degenerative	112	42,1	5	1,9	117	44,0
Ischemic	11	4,1	61	23,0	72	27,1
Drugs	17	6,4	48	18,0	65	24,4
CPA in asystole	1	0,4	8	3,0	9	3,4
Failure in pacing	3	1,1	0	0	3	1,1
Total	144	54,1	122	45,9	266	100,0

$X^2=155,159$ $p= 0.000$

the use of temporary PM (Table 2) were significantly associated ($p = 0.002$). The degenerative cause showed a similar number of cases in the group of less than 72 hours (54 patients, 20.3%) and in the group from 72 hours to 7 days (59 patients, 22.2%). The highest proportion of patients with acute coronary syndrome (ACS), and those who were mediated by negative chronotropic drugs, showed a duration of therapy higher than 7 days (48 cases, 18.0%, and 44 patients, 16.5%). The largest number of patients with CPA in asystole remained with temporary cardiac pacing for less than 72 hours (7 cases, 2.6%). The 3 patients (1.1%) with a failing permanent PM (PPM) needed a

temporary pacing time of less than 72 hours.

Table 3 shows that the statistical association between the use of TPM and the need for PPM implantation was highly significant ($p = 0.000$). The degenerative cause (112 cases, 42.1%) was the major cause for permanent pacing. Of a total of 72 patients (27.1%) who were diagnosed with ACS, 11 required permanent pacing. Permanent PM were also implanted in 17 (6.4%) of the 65 patients who had negative chronotropic drug poisoning.

The distribution of patients, according to the complications associated with jugular and subclavian venous access routes (Table 4), showed statistically sig-

Table 4. Distribution of complications, according to venous access routes.

Complications	Deep venous access routes							
	Jugular		Subclavian		Femoral		Total	
	Nº	%	Nº	%	Nº	%	Nº	%
Unwanted vessel puncture	15	5,6	4	1,5	0	0	19	7,1
electrode displacement	14	5,3	2	0,8	0	0	16	6,0
Arrhythmias	5	1,9	3	1,1	0	0	8	3,0
Hematomas	7	2,6	1	0,4	0	0	8	3,0
Pneumothorax	0	0	2	0,8	0	0	2	0,8
None	198	74,4	14	5,3	1	4,0	213	80,1

$\chi^2 = 31,004$ $p = 0,001$

significant differences ($p = 0,000$). Puncture of unwanted vessels was the most common complication with 19 patients (7.1%); and it was more frequent in the jugular access route. The displacement of the electrode was the second most common complication (16 cases, 6.0%); in this case, the jugular access route also showed the highest frequency (14 patients, 5.3% of total). Pneumothorax, by subclavian access route, only occurred in 0.8% of patients; and 80.1% of patients did not show any complication.

Figure 1 represents the main conduction disturbances that led to the implantation of TPM. Third-degree AV block was the most prevalent (43.4%),

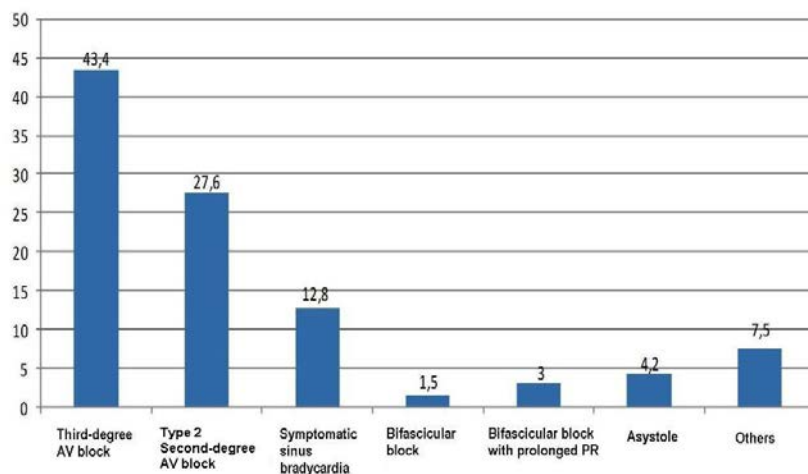


Figure 1. Distribution of patients according to the type of conduction disturbance that led to TPM implantation.

followed by type 2 second-degree AV block (27.6%), sinus bradycardia (12.8%), asystole (4.2%), bifascicular block (1.5%), bifascicular block with prolonged PR interval (3.0%) and others (7.5%).

DISCUSSION

In a study of quality of life in 169 patients with AV block and TPM, Ardashev *et al.*¹² found a mean age of 67.5 years, which is slightly lower than the results found in this study. With regard to sex, they found a substantially different pattern, where male were predominant with 84.1%. In a study published in 2005, which analyzed the characteristics of patients who

required PM implantation after cardiovascular surgery, it was noted that the mean age (72.5 years) of those who needed it was higher than the mean age of those who did not require the implantation¹³. Moreover, Lopez Ayerbe *et al.*⁷ found a mean age of 74.8 years with a slight male predominance (54%), which is similar to our results.

In a prospective multicenter study, males predominated (63.4%)¹⁴, however, in ours, the existence of a predominantly aging population favored the similarity between the sexes, because degenerative and chronic noncommunicable diseases are on the same level, as a result of the loss of estrogen protection after

climacteric¹⁵.

Melgarejo *et al.*⁹ reported that of 55 patients who were implanted with TPM (4.4% of their sample), 3 cases needed PPM, 2 patients because of the persistence of type 2 second-degree AV block (more than 15 days), and a third patient due to recurring third-degree AV block with the presence of new-onset bifascicular block.

The average time for temporary cardiac pacing was 4.2 days (range, 1-31 days) for López Ayerbe⁷, and 2 days (0.04 - 20 days) for Betts¹⁴ and Muñoz¹⁶.

The nature and prognosis of conduction disturbances after AMI are different from those of other situations. Moreover, in this case, the use of PPM depends on the coexistence of AV block and intraventricular conduction defects. It must be remembered that in patients with inferior infarction, conduction disturbances may be transient (usually resolve in 7 days) and are usually due to edema of the atrioventricular node and a predominance of vagal tone. Therefore, in these cases, there is usually no need to implant a PPM. Regardless of the topography of AMI, atrioventricular conduction disturbances may be reversed with the use of anti-ischemic therapy, as long as the injury in the conduction system is not irreversible. The recommendations for the use of PPM are reserved for persistent disorders (over 14 days). This explains the long use of TPM in patients with ACS^{1,17}.

The actions to take in case of poisoning with negative chronotropic agents is the protection of the patient with the use of temporary pacing, as long as it is required, until reaching three half-lives of the drug. If conduction is not recovered, a PPM is implanted; therefore, the need for temporary cardiac pacing lasts longer in many cases¹.

López Ayerbe *et al.*⁷ recorded a total of 369 patients (69.6%) requiring PPM during their stay; Betts¹⁴ recorded 22.9% and Winner¹⁸ 36%, while Murphy¹⁹ reported 56 cases of a total of 129 patients requiring temporary cardiac pacing.

Jou *et al.*²⁰ noted a predominance of degenerative causes, compared with ACS (61% vs. 21%), and reported 67.5% of PPM implantations due to intrinsic causes (ischemic and idiopathic degenerative causes) while permanent stimulation due to extrinsic causes (mediated by drugs), accounted for 3.8% of the study.

Clinical practice guidelines on PM and cardiac resynchronization therapy state the same use for PPM implantation in spontaneous and drug-induced con-

duction disturbances, in the absence of alternative pharmacotherapy. In the case of ACS, its use is considered in third-degree AV block and in persistent type 2 second-degree AV block (more than 14 days)¹.

Our series shows a higher proportion of PM implantations due to the predominance of degenerative causes.

López Ayerbe *et al.*⁷ reported that 22% of their cases had some kind of complication related to TPM implantation; results that are in agreement with those in our study. These authors found 48 patients with electrode displacement (9.1%), 15 patients with hematomas and arrhythmias (2.8%). Less frequently (less than 1%), they found fever, cardiac tamponade, deep vein thrombosis, sepsis and others.

Betts¹⁴ reported a complication rate of 31.9% in their study. Unwanted vessel puncture and pneumothorax were observed in 2 patients (1.4%), and electrode displacement was the most common complication (16%). Muñoz *et al.*¹⁶ found hematoma (13.2%), displacement of the electrode (9.9%) and infection (2.7%). It is noteworthy the absence of infection in our series, in contrast with other publications such as Murphy¹⁹ (1.7%), Morgan *et al.*²¹ (1%) and Muñoz *et al.*¹⁶.

These results justify extreme aseptic and antiseptic conditions, despite the great urgency with which PM are implanted. The most effective way to prevent infection of a PM is the use of a meticulous surgical technique during its implantation. This includes a careful preparation of the skin, a precise location of the skin incision, strict aseptic and antiseptic measures, effective hemostasis and avoidance of drainage. It is not common to use prophylactic antibiotics, and indeed our patients did not receive them. Some authors recommend their routine use, while others reserve them for prolonged procedures²².

In our study, the venous access route most commonly used for TPM implantation was the jugular route, followed by the subclavian route. In a historical compendium that reviewed publications from 1973 to 2011²³, a detailed review of the access routes for TPM implantation was conducted. In the series of Murphy¹⁹ and Betts¹⁴, it is reported that the internal jugular vein was the most commonly used access route (46.8 and 68%, respectively). Birkhahn *et al.*²⁴ (96.6%) and Harrigan *et al.*²⁵ (76%) are consistent with these results and with our results. However, López Ayerbe *et al.*⁷ reported primarily the use of femoral access route (99%).

Although a clear superiority of one venous route over the others has not been demonstrated, it is always necessary to spare the subclavian vein, so it may be used for the subsequent implantation of a PPM.

There are many causes for TPM implantation. Betts¹⁴ recorded 61.3% for advanced AV block, while sick sinus syndrome and other types of bradycardia accounted for 9.9% and 7.2%, respectively. Muñoz *et al.*¹⁶ reported as the most frequent causes the third-degree AV block (66.5%), the high-grade symptomatic AV block (10.4%), bradyarrhythmias secondary to drug poisoning (12.1%) and sick sinus syndrome (9, 3%).

Another study identified, among the most frequent causes, the symptomatic type 2 second-degree AV block in 270 cases (51%), the prophylactic use for replacement of the generator in patients with PPM, 78 cases (14.7%), bradyarrhythmias due to drug poisoning in 65 patients (12.2%), symptomatic sick sinus syndrome in 39 patients (7.4%) and the presence of long QT interval or ventricular tachycardia in 13 patients (2.5%)⁷.

CONCLUSIONS

The use of temporary cardiac pacing is more common in people over 80 years of age, mainly because of degenerative causes, which eventually leads to permanent pacing. The complication rate is not high considering that this procedure was not performed under fluoroscopic view.

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