Temporary Pacing

OPSOMMING

Daar is heelwat indikasies vir die aanbring van 'n tydelike transveneuse pasaangeër. Daarom moet verpleegpersoneel wat nie noodwendig direk in kardiologiese eenhede werk nie kennis dra van die tegnieke vir die aanbring van tydelike pasaangeërs, die versorging van hierdie pasiënte en moontlike komplikasies.

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INTRODUCTION

Artificial cardiac pacing, the use of electrical stimuli to cause contraction of heart muscle, is a sophisticated therapeutic and diagnostic tool. Its rapid technologic improvement since first developed in the late 1930's by Hyman, has made it possible not only to avoid certain cases of death due to heart block, but also to extend and improve the quality of life. Pacemaker therapy is generally used to treat heart rate or rhythm disturbances, being either tachy- or bradyarrhythmias that produce a detrimental drop in cardiac output. Of the many different types of pacemakers and electrodes currently available, ventricular demand pacing is dhe most commonly used.

The insertion of permanent pacemakers and the care of patients with permanent pacemakers is performed in specialised centres by highly trained staff. Temporary transvenous pacing is used to support patients until a permanent pacemaker can be inserted. In addition, certain patients develop transient reversible conduction disturbances after myocardial infarction. They require temporary pacing at this time, though they very rarely require the insertion of a permanent pacemaker. A further small sub-group of patients are, by nature of their underlying disease, at risk of complete heart block and may need a temporary pacemaker to cover induction of anaesthesia. Temporary pacing may also be used to control tachyarrhythmias. Because of the widespread applications of temporary pacing, nursing and paramedical staff in areas not directly related to cardiology require a knowledge of techniques of insertion and care of patients with temporary pacemakers.

INDICATIONS FOR TEMPORARY PACING

Awaiting insertion of permanent pacemaker

Temporary pacing may be indicated while the patient is awaiting insertion of a permanent pacemaker for the following:

- **Second degree AV block, Mobitz Type II**

This is characterised by regular 'p' waves that periodically fail to initiate the ventricular response, but without prior P-R interval prolongation (as distinct from the Wenckebach phenomenon). (See figure 1)

- **Complete heart block**

This is characterised by regular 'p' waves which do not initiate ventricular response. There is a complete dissociation between the 'p' waves, which are usually at a rate of about 80 per minute, and the QRS complexes which are usually at a rate of about 40 per minute. (See figure 2)

- **Sympomatic Sick Sinus Syndrome (SSS)**

The main ECG manifestations of SSS are:

— marked and persisting sinus bradycardia resistant to drug therapy (such as atropine or isuprel)

— sinus arrest or sino-atrial block. In cases of far advanced SA Block or sinus arrest, the sinus activity is almost completely or, at times, entirely absent, leading to atrial standstill.

— chronic atrial fibrillation or atrial flutter with a slow ventricular response (see figure 3)

— carotid sinus hypersensitivity may result in syncope. This is characterised by sudden development of sinus arrest, complete heart block or ventricular standstill following stimulation of the carotid sinus (see figure 4)

— failure of restoration of sinus rhythm following cardioversion (see figure 5)

Acute myocardial infarction

A temporary pacemaker may be indicated during the course of acute myocardial infarction in the following instances:

— symptomatic bradycardias due to any mechanism as a result of acute myocardial infarction, usually in patients with inferior infarction

— bifascicular block in patients with acute anterior infarction, such as left anterior hemiblock and complete right bundle branch block. This is characterised by typical right bundle branch block with left axis deviation.

Control of arrhythmias

Temporary pacing can be used to control the following arrhythmias:

— symptomatic drug-induced (such as digitalis) bradyarrhythmias

— drug resistant tachyarrythmias.

They may be treated by the following pacing methods:

- pacing the atrium or ventricle at variable rates can suppress ectopic activity and thus prevent recurrent attacks of the tachyarrhythmias
- overdrive pacing is often successful in converting atrial flutter to sinus rhythm by pacing the atrium at a faster rate than the tachyarrhythmia
- with single or multiple programmed extra sitmuli it is also possible to interrupt both atrial and ventricular arrhythmias

— ventricular standstill which may be due to hypersensitive carotid sinus, a manifestation of SSS, drug induced (for example di-

Figure 1: ECG of Second degree AV block

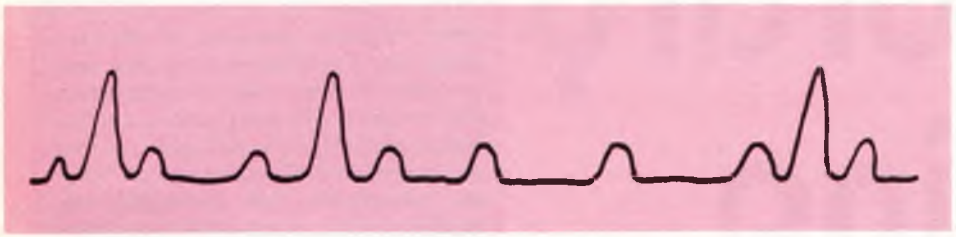


Figure 2: ECG of complete heart block

Figure 3: ECG's showing chronic atrial fibrillation and atrial flutter

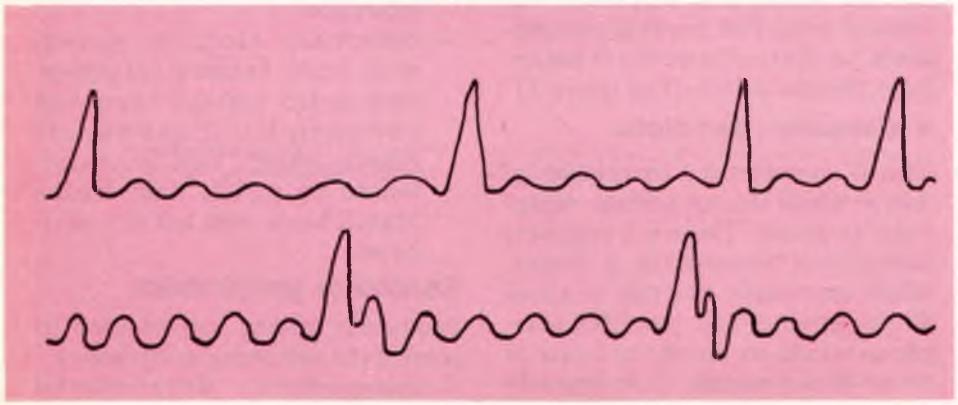


Figure 4: ECG showing carotid sinus hypersensitivity

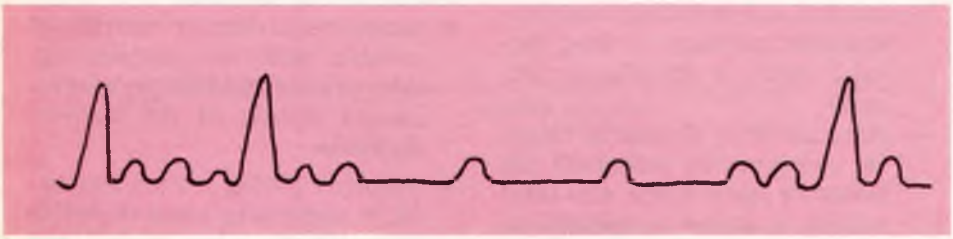


Figure 5: Failure of restoration of sinus rhythm.

goxin toxicity) or electrolyte imbalance (for example hyperkalemia.)

Other indications

Other indications for temporary pacing are prophylactic pacing during and immediately after major cardiac surgery and diagnostic pacing in electrophysiological studies. Conduction abnormalities can be confirmed and precisely identified through the use of intracardiac recordings via special multipolar pacing and sensing electrodes.

TECHNIQUES

The transvenous techniques of electrode placement has become the most clinically acceptable approach to the right heart chambers for either atrial or ventricular pacing.

Positioning and types of electrodes

Ventricular Pacing

The electrode is positioned in the apex of the right ventricle. The electrodes currently used are:

- a bipolar 7f woven dacron electrode. (Should the doctor anticipate the problem of perforation as he may encounter in patients with an inferior infarction, a smaller size electrode may be used)
- a bipolar floating electrode, either Swan Ganz or Berman (these may be used in an emergency and positioned without fluoroscopy).

Atrial Pacing

An atrial pacing electrode is positioned in the right atrium. The right atrial appendage is the best site for atrial pacing but it is often difficult to maintain the position, therefore the electrode may be positioned to lie against the lateral wall of the right atrium. The electrodes currently used are:

- the quadropolar 7f woven dacron electrode
- the Berman pacing electrode with stylettes to facilitate positioning of the electrode in the right atrial appendage.

TRANSVENOUS ROUTES

There are four venous routes:
Subclavian vein (the left side is used to leave the right clear for possible insertion of a permanent pacemaker system)
Brachial vein (either side may be used but the right is easier)

Femoral vein (either side may be used)
Jugular vein (either the internal or external).

The subclavian vein approach

This route is usually preferred due to its fairly direct access to the heart and easy location. Extreme care must be taken in patients with chronic obstructive airways disease as the risk of causing a pneumothorax is high. Access to the vein is by direct puncture using the Seldinger technique. This may be performed supra- or infra-claviacularly.

The brachial vein approach

This is indicated in patients with bad chronic obstructive airways disease and in those who have suffered injury to the head or neck making subclavian vein entry difficult.

The jugular approach

This is less commonly used. The choice of subclavian or jugular approach is largely determined by the expertise and training of the operator. Both techniques have individual disadvantages.

The femoral vein approach

This is rarely used because of concern over infection but is satisfactory for short periods. When used, access is by direct puncture.

Site preparation and entry

A good sterile technique is essential. The chosen site is cleaned with an antiseptic solution such as providone iodine and the area is covered with sterile towels. Lignocaine 2 % is used to anaesthetise the area. (1 % may be preferred if the patient is in complete heart block).

The vein is entered either percutaneously using a Pott's Cournand needle and sheath set or by direct cut-down onto the brachial vein.

The pre-selected pacing electrode is advanced into the right atrium under careful fluoroscopy. The electrode is advanced further through the tricuspid valve and into the right ventricle. If the patient has been on an isoprenaline infusion this must be stopped as soon as the electrode is in the right atrium as it might cause ventricular irritability. The electrode is carefully advanced into the pulmonary artery. The only way to determine whether the electrode is in the right ventricle (rather than the coronary sinus, which often looks like the right ventricle) is to advance it until it is in either the right or the left pulmonary artery outside the shadow of the heart (see figure 6). Once this has been accomplished the electrode is slowly withdrawn and twisted until it falls into the apex of the right ventricle (see figure 7).

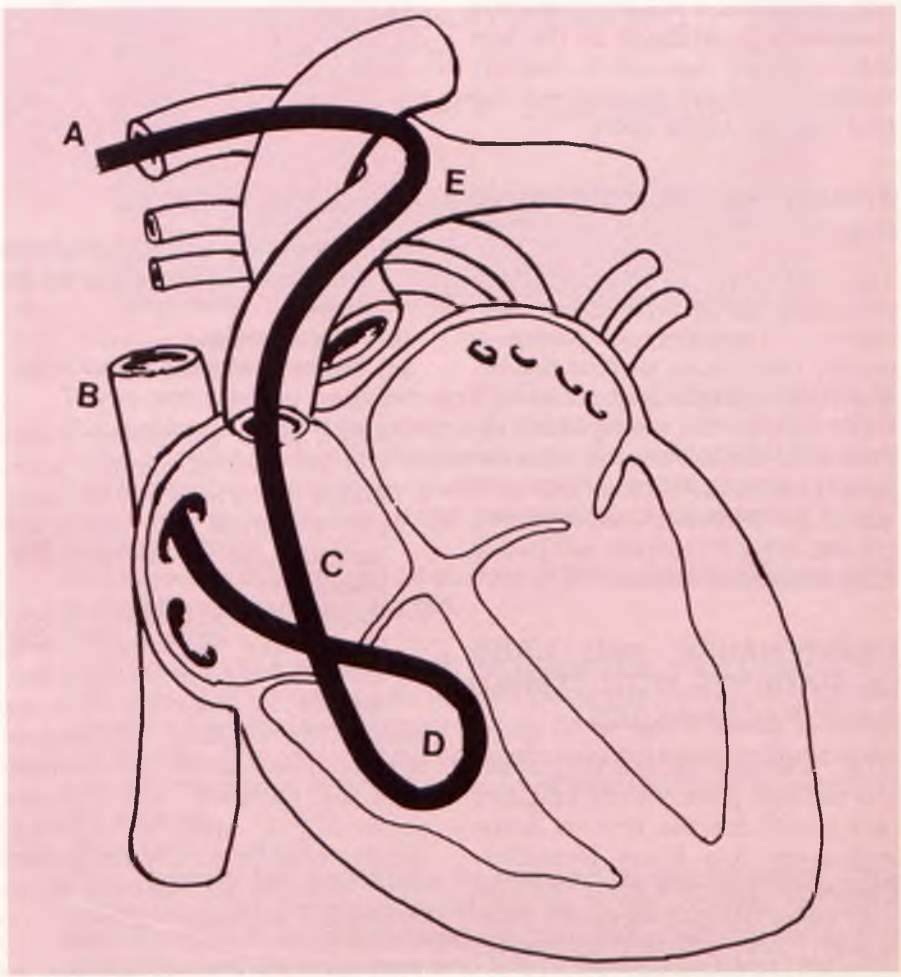
The external pulse generator (see figure 8) is attached to the distal terminals of the electrode. The one marked **distal** is attached to the **negative** terminal of the pulse generator and the other to the positive.

The threshold is determined by slowly increasing the MA until ventricular pacing is initiated or starting at a high MA and slowly decreasing the MA until ventricular capture is absent. The threshold is the minimum amount of current that is needed to initiate ventricular response and should be under 1 MA. Should the threshold be greater than 1 MA another site in the right ventricle must be tried.

Reasons for a high threshold or absence of pacing include:
— a faulty pulse generator (try another pacemaker box)
— the catheter electrode incorrectly positioned, either having perforated the right ventricle or being incorrectly sited in the coronary sinus
— a fractured electrode (this will be noticed by an absence of pacing spikes on the ECG when pacing is started)
— an unstable position in the right ventricle, such as just through the tricuspid valve and not in the apex.

The patient is told to take a couple of deep breaths in and out and to cough. This is to see whether the threshold is still adequate, that is under 1 MA, with deep inspiration.

Figure 6 Diagrammatic representation of a temporary pacing electrode positioned in the right pulmonary artery



(a) Temporary pacing electrode positioned in the right pulmonary artery
(b) Superior vena cava
(c) Right atrium
(d) Right ventricle
(e) Main pulmonary atery at the bifurcation

Sensing thresholds are taken to ensure that spontaneous ventricular depolarisation will inhibit the pulse generator. It is also important to ensure that the sensitivity is not that high that it will sense P or T waves of large amplitude. When taking sensitivity thresholds the rate dial is turned to a value below the patient's intrinsic rate. At this rate, the ECG should indicate that the external pacemaker has stopped pacing the heart, the sense light indicator should be flashing showing that the patient's R waves are being sensed. Slowly turning the sensitivity dial anti-clockwise, observe at what point the external pacemaker stops sensing and starts to pace. This will be the sensitivity threshold. When the sensitivity dial is set on maximum, that is 1 millivolt, the external pacemaker may sense large voltage P or T waves and interpret these as R waves. Should this happen the sensitivity should be decreased to, for example, 3-5 millivolts.

The electrode is secured to the skin with a black silk stitch and the pacemaker is strapped to the arm with a special pacemaker strap. A sterile dressing is applied and the lead securely taped down.

Emergency transthoracic pacing

This approach hastens electrode positioning during resuscitation manoeuvres. Transthoracic pacing is usually done using an *Iseri* needle. The right ventricle is punctured directly using the subxiphoid approach or the left ventricle via the apex. Once a good blood flow is obtained the wires are advanced into the left or right ventricle and pacing initiated immediately.

MAINTENANCE AND CARE OF PATIENTS WITH TEMPORARY PACEMAKERS

After insertion of the pacemaker the patients pulse should be taken half hourly for the first six hours and every two hours thereafter. Should the patient's heart rate register under the rate set on the pacemaker, this indicates pacemaker malfunction which may be due to:

— dislodgement of the electrode (this will need to be repositioned in the catheterisation laboratory).
— faulty pacemaker box or electrode (this will be noticed on the ECG as no pacemaker spikes will be seen, if another pacemaker box is used and the same problem arises, the patient will have to have another electrode inserted)
— loose terminal connections, these may sometimes work loose and need to be tightened.

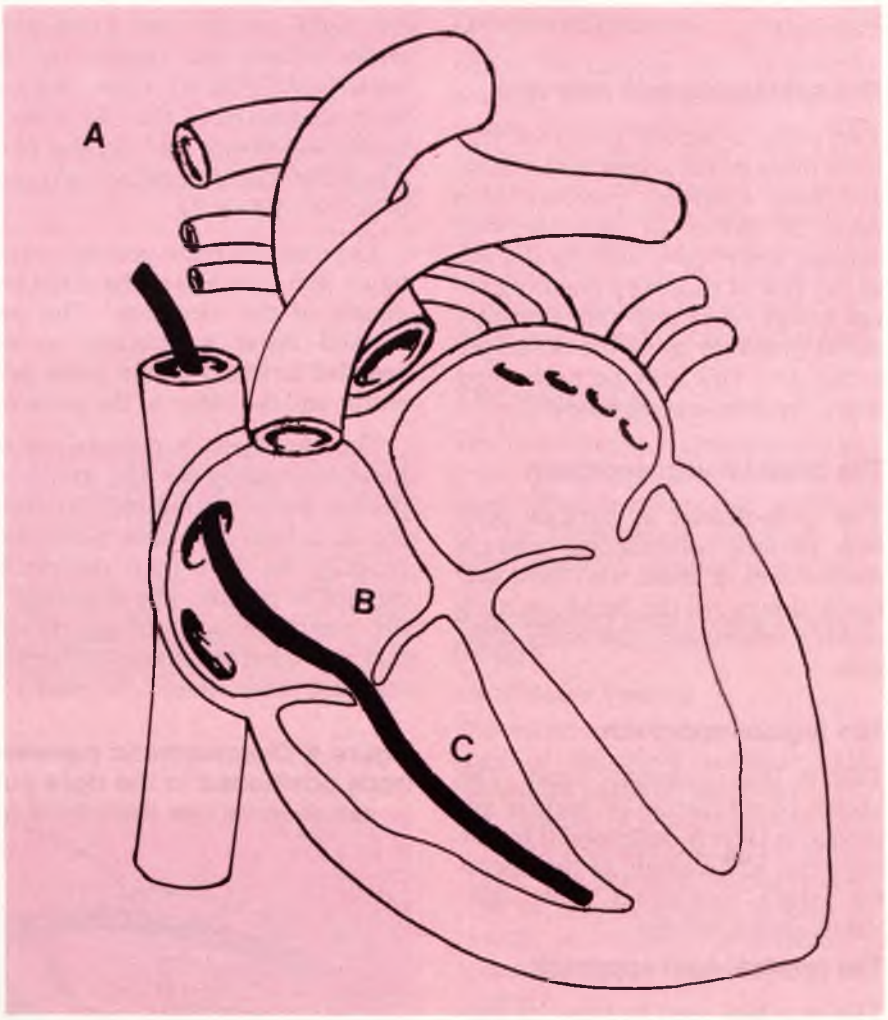
The site of insertion must be checked for swelling, bleeding or redness. Four hourly temperature must be recorded and any rise above 37 ° C must be reported. Sterility must be strictly maintained when changing the dressing as infection is a common problem.

At no stage may the settings on the pacemaker be changed without a doctor's supervision. Should the patient become asystolic, the MA should be increased. Should this still not produce pacing, the demand dial should be turned to fixed rate pacing. If asystole persists, give a hard praecordial thump and commence cardio-pulmonary resuscitation. Should there be any doubt whatsoever as to the effectiveness of cardiac pacing, external massage must be resumed immediately.

Should the pacemaker electrode be situated in the arm the patient must be instructed not to use this arm and to keep it loosely at his side. Patients must be instructed not to use electric razors and care must be taken not to approach the patient with any main cord electrical equipment as this might interfere with the pacemaker.

Should the patient need to be defibrillated, the pacemaker must be switched off and the terminals removed. If the patient goes for surgery, the theatre staff should be aware that diathermy must not be used.

Figure 7: Diagrammatic representation of a temporary pacing electrode positioned in the apex of the right ventricle



(a) Temporary pacing electrode positioned in the apex of the right ventricle having entered the venous system via the subclavian vein.
(b) Right atrium.
(c) Right ventricle.

COMPLICATIONS

Possible complications of temporary cardiac pacing are the following:

- failure to pace due to
  fracture of the electrode
  faulty generator
  loos terminals
  electrode dislodgement
  electro-mechanical dissociation.
- sensing failure. The pacemaker fails to sense the patient's intrinsic heart rate and emits inappropriate impulses. Should one of these fall in the vulnerable period of the patient's QRST complex it may provoke serious ventricular arrhythmias, either ventricular tachycardia or ventricular fibrillation
- arrhythmias, either atrial or ventricular. The electrode may cause irritation to the right ventricle causing premature ventricular beats, ventricular tachycardia or ventricular fibrillation
- perforation of the heart (not uncommon but usually without serious sequelae)
- infection
- thrombo-embolic phenomena (uncommon)
- knotting of the electrode while positioning it
- neurological reaction to lignocaine
- asystole due to lignocaine
- pneumothorax during subclavian vein approach
- interference of the pacemaker due to electrical signals
- venous spasm during introduction of the electrode into the brachial vein.

REFERENCES

1. Thalen, H J *Cardiac Pacing.*
2. Chung, EK *Artificial Cardiac Pacing.*

ACKNOWLEDGEMENTS

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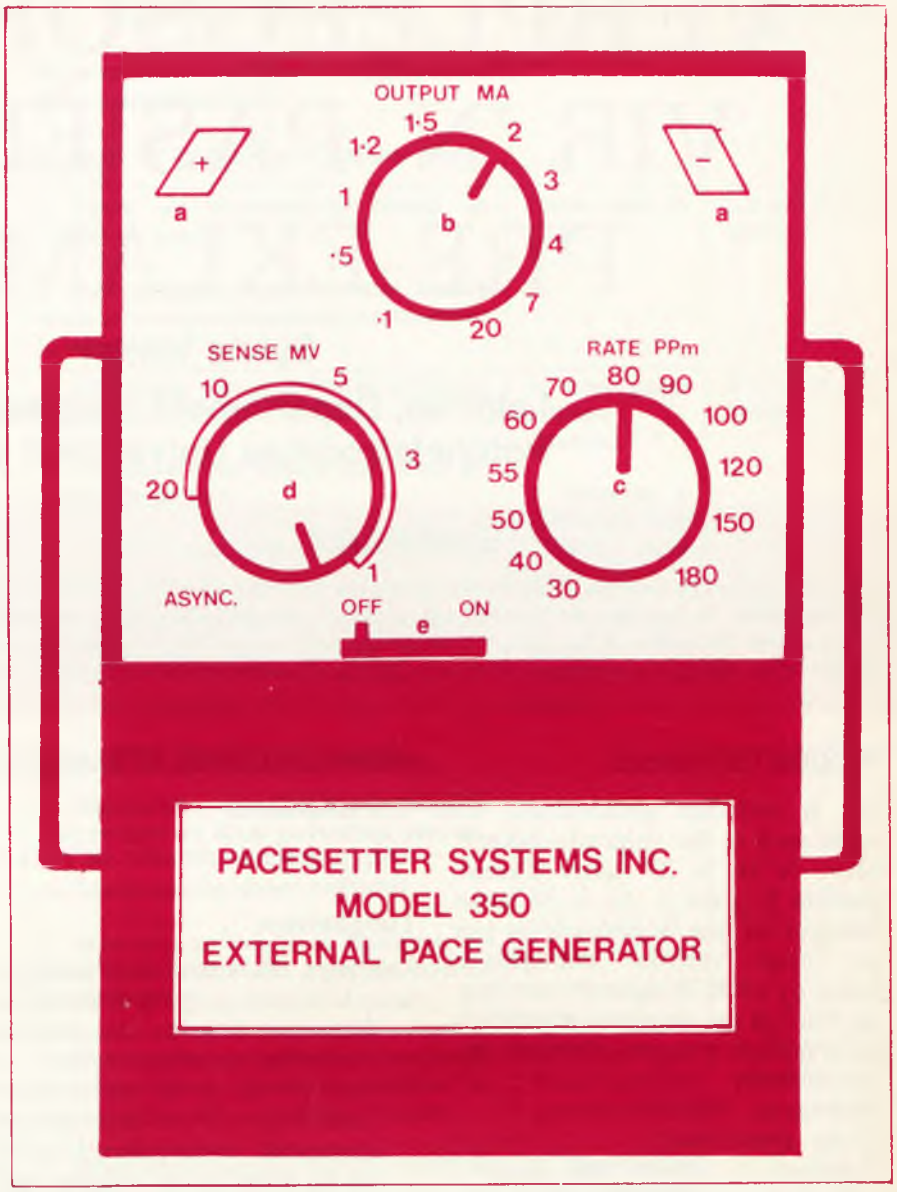
Figure 8 An external pulse generator



(a) Output Terminals
These are marked negative and positive. The distal terminal of the electrode should be placed in the negative socket, the other in the positive socket. In this pacemaker the terminals of the electrode may be released by pushing the output terminals downwards (some are on top of the generator and are a screw type).

(b) Output Control
This governs the amount of current at the output terminals. This is usually set between 2-3 MA.

(c) Rate Control
This governs the rate at which the pacemaker will emit electrical impulses. This is usually fixed at 70 beats per minute. Should the patient's own rate be adequate it may be turned down to 40 beats per minute. The moment the patient's rate falls below that set on this dial the pacemaker will begin to deliver electrical impulses at the set rate.

(d) Sensitivity Control
This governs the sensitivity to respond to the incoming QRS signal from the patient. Should this be in the extreme left hand position (that is asynchronous) the pacemaker will not sense the patient's own QRS complex and will function as a fixed rate unit. This is dangerous and could cause the patient to go into ventricular fibrillation. The dial should be set between 1 and 3 millivolts.

(e) On/Off Switch
This is a slide switch. Some of the other units however, have a push-button switch with a safety slide device.