# Current Status of Artificial Cardiac Pacing

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HEART BLOCK and the clinical Stokes-Adams syndrome are intimately associated with myocarditis and myocardial scarring and, therefore, usually a secondary finding to more primary pathology associated with heart disease.

Friedberg *et al.*[1] report, in an examination of 100 consecutive cases of Stokes-Adams syndrome due to heart block, that the predominant underlying or associated disease is coronary heart disease either in the form of coronary disease alone or in association with hypertension or by acute myocardial infarction. To this list we might also include surgically induced heart block in the correction of certain congenital and acquired cardiac lesions.

Regardless of cause, a lesion in any part of the conduction system between the atrioventricular node of Tawara and the bundle of His to the right and left ventricles will present an obstacle to the conduction impulse. Thus, while the auricle continues to beat at the normal rate, the ventricles will beat at a much slower rate resulting in marked bradycardia.

The chief effect is felt by the brain and is due to the cerebral ischemia produced because of the associated ventricular arrhythmias, ventricular standstill, or the extreme bradycardia. The cerebral disturbance of syncope can be associated with convulsions, the syndrome first described by Stokes in 1846.[2] He said, "The fits are induced by any circumstances lending to impede or oppress its heart's action, such as sudden exertion, distended stomach or constipated bowels. There is little warning given of the approaching attack. He feels, he says, a lump first in the stomach, which passes up through the right side of the neck into the head, when it seems to explode and pass away with a loud noise resembling thunder, by which he is stupified. The duration of the attack is seldom more than four or five minutes, and sometimes less; but during that time he is perfectly insensible." The syndrome occurs sooner or later

[1] C. H. Friedberg, *et al.*: *Annals New York Academy Science, 111:* 835, 1964.

[2] W. Stokes: *Dublin Quarterly Journal Medical Science, 2:* 73, 1846.

in the majority of cases of complete heart block and is often associated with congestive heart failure which may be refractory to conventional treatment until the deleterious effects of the conduction block have been abolished.

## *Methods of Treatment of Heart Block*

The treatment of complete heart block falls into three categories: 1) prophylactic measures, such as avoidance of factors which tend to precipitate attacks. These factors include emotional upsets and strenuous exertion, which tend to precipitate syncope since the cardiac output is fixed regardless of the increased demand. Dietary regimens producing acidosis and hyperpotassemia, and drugs such as quinidine and procaine amine, which depress the conduction system, should be eliminated; 2) drug therapy, aimed at the improvement of A-V transmission and the removal of those factors which tend to depress A-V transmission; 3) use of electrical devices either external or internal to stimulate the ventricles to beat at a more physiologic rate.

All three methods of therapy play a role in the care of the patient with complete heart block. Prophylaxis and drug therapy go hand in hand and should be tried first Clinical judgment determines when an artificial pacemaker is indicated and when medical therapy should be abandoned.

## *Pacemaker Implantation*

Burchell *et al.*[3] state that the basic indications for implantation of an artificial pacemaker have not changed in recent years and are 1) disabling, frightening episodes of unconsciousness related to ventricular standstill (or ventricular tachycardia) with heart block, 2) the potentiality of sudden death in patients with disturbances in A-V conduction, and 3) symptoms of heart failure or inadequate cerebral perfusion attributed to slow ventricular rates. Bellet[4] believes that medical therapy should be abandoned in favor of a artificial pacemaker when drug therapy has been unsuccessful or only partially efficacious in controlling the Stokes-Adams attacks, refractory heart failure, episodes of shortness of breath, easy fatigability, and/or precordial pain at rest or on slight effort.

As pacemakers have become more reliable and as implantation techniques have improved, the use of the artificial pacemaker has become the procedure of choice in complete heart block. The contractile response of the heart to repetitive electrical stimuli has been of interest to the physiologist over the years. It was Walshe,[5] in 1862, however, who suggested the clinical application of this phenomenon. In 1952, Zoll[6] established the routine clinical practice of using an external pacemaker to treat heart block by placing skin electrodes on the chest wall and pacing the heart from without. Weirich *et al.*[7] in 1957 introduced the use of a myocardial electrode brought out through the chest wall at the time of operation. This maneuver greatly decreased the amount of current necessary to stimulate the myocardium and made feasible the concept of a small battery-powered pacemaker implanted entirely within the body.

At present, two general types of cardiac pacemakers are in use, one external, the other internal. The first type utilizes an outside power source and oscillator circuit to generate

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[3] H. B. Burchell, *et al.*: *American Journal Medicine, 37:* 764, 1964.

[4] S. Bellet: *Annals New York Academy Science, 111:* 835, 1964.

[5] W. H. Walshe: Blanchard & Lea, Philadelphia, 1862.

[6] P. M. Zoll: *New England Journal Medicine, 247:* 768, 1952.

[7] W. L. Weirich, V. L. Gott, and C. W. Lillehei: *Surgical Forum, 8:* 360, 1957.

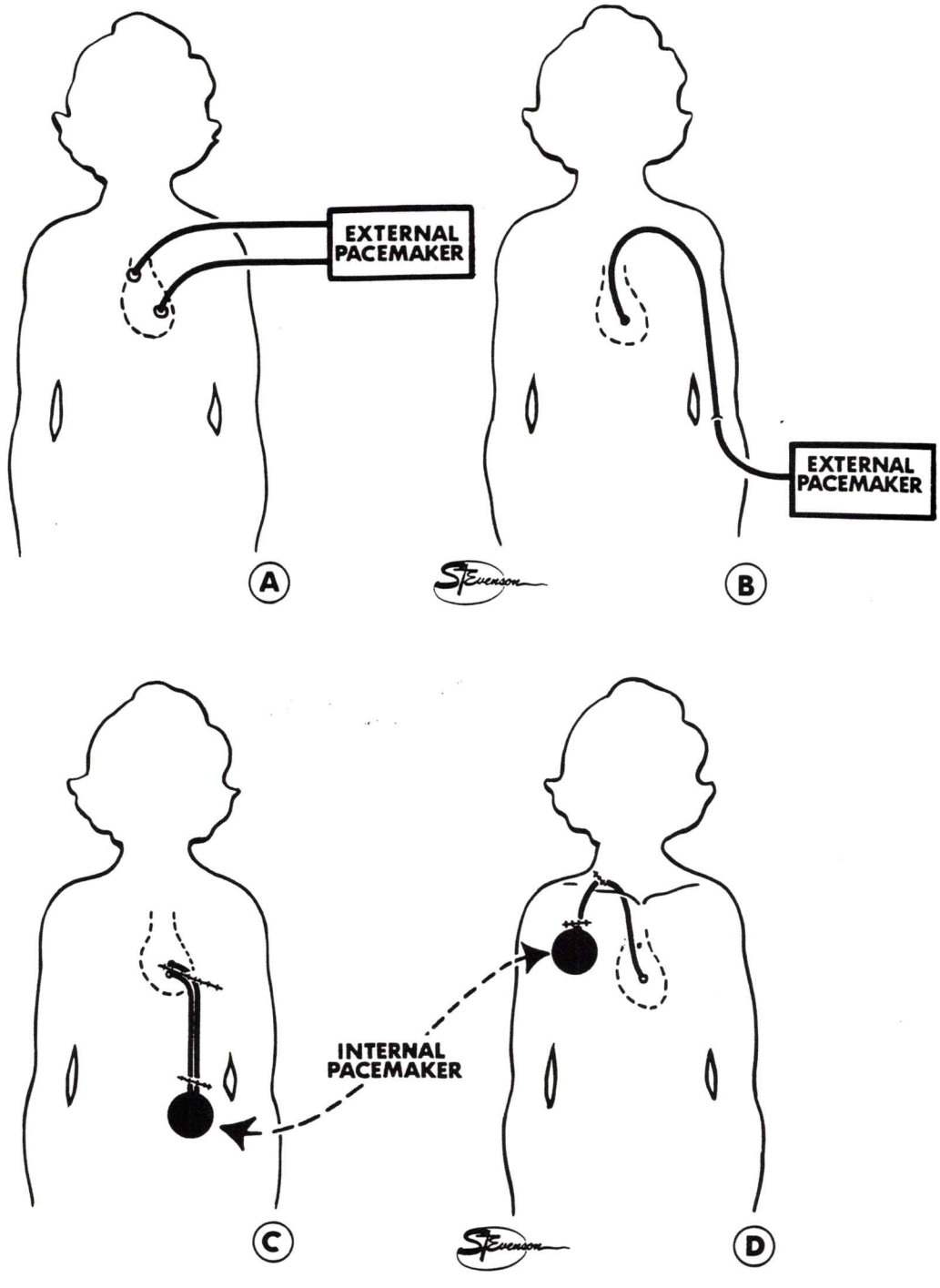
EXTERNAL PACEMAKER
EXTERNAL PACEMAKER
A
B
INTERNAL PACEMAKER
C
D

FIG. 1

the desired pulse rate. With this system the myocardium can be stimulated indirectly through the chest wall by the application of external electrodes placed on the skin (Fig. 1*A*) or directly by passing an electrode via a peripheral vein into the right ventricle (Fig. 1*B*). The second type of pacemaker is a small, self-contained oscillator system with its own power source (batteries) and electrodes which can be completely implanted within the body. The electrodes can be attached to the heart either by direct implantation into the myocardium or by the external venous jugular route into the right ventricle (Figs. 1*C* and *D*).

## *External vs. Internal Implantation*

Each type has its advantages. External pacemakers can be applied immediately and are satisfactory for emergency use. Their accessibility greatly reduces the problem of maintenance and repair. The chief disadvantage associated with this type is the pain and sometimes burning of the skin at the site of the electrodes. Psychologically, however, the patient feels more secure about his well-being if the lifesaving instrument is implanted and out of sight. A further advantage of an implanted pacemaker system is that the patient has a greater freedom of movement and comfort and there is no pain associated with the stimulation. The main disadvantage is that a minor surgical procedure is required to correct a battery failure or repair a broken electrode. This has occurred in less than 10% of the cases we have treated.

To date most implantation techniques require a small left anterior thoracotomy incision in order to place the electrodes into the myocardium. A small incision is also made in the upper left quadrant of the abdominal wall, anterior to the rectus sheath, to create a pouch for the power pack. An interconnecting tunnel for the electrodes establishes continuity between the heart and power source. The risk of opening the chest of an elderly patient makes this procedure less desirable than the procedure as outlined in Figure 1*D*. Here the pacemaker electrode is threaded into the external jugular vein through a small cervical incision and is fixed in the apex of the right ventricle under fluoroscopic control. The power pack is implanted under the subcutaneous tissues overlying the right pectoralis muscle. Continuity between the electrodes and power pack is established via a subcutaneous tunnel from the neck, over the clavicle to the chest. The obvious advantages of not opening the chest and the use of local anesthesia is apparent. A catheterization laboratory facility, however, is needed to perform this procedure in order to assure proper placement of the catheter electrode. Although there are isolated instances of the catheter electrode eroding through the myocardial wall, withdrawal of the catheter back into the ventricle does not result in tamponade.[8] In the debilitated elderly patient, the advantages cited above are worth the risk.

## *Conclusion*

Instrumentation and implantation techniques are now available to manage most cases of complete heart block. Reliability of components has greatly improved. Rigorous testing procedures will further improve reliability. At the present time, implantable pacemakers have decreased the mortality and morbidity of patients with cardiogenic syncope and is the treatment of choice in complete heart block.

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[8] W. M. Chardack: Personal communication.