Editorial

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"Physiological" pacing

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Perhaps because cardiac pacing stands at the frontiers between cardiology, electronics, and surgery, controversy has invariably arisen with the appearance of each technological innovation. Now another advance, "physiological" pacing, has passed through its initial trial period and stands at the crossroads.

Lack of confidence in the reliability of new technology, high initial complication rates, and high costs militate against the immediate and widespread use of new forms of pacing. These concerns have quite understandably led those involved in pacemaker implantation to question the real need for each innovation. Now that the pacing fraternity is confronted (in reality for the second time[1]) with yet another development, it is appropriate to examine the relation between it and the factors that previously retarded progress, in the hope that a speedier resolution may be obtained.

The term "physiological pacing" has the merit of brevity and little else. Any form of cardiac pacing is more physiological than the bradycardia it is intended to correct, at least when the mechanism is atrioventricular block. Nevertheless, the term is conveniently used to enable those advanced pacing modes which result in normal synchrony between atria and ventricles and/or responsiveness of the heart rate to the needs of the patient to be considered together.

There can now be no doubt of the advantage of atrial synchronous pacing over the ventricle inhibited variety for patients with atrioventricular block. Exercise tolerance is higher in the atrial synchronous mode when testing is performed shortly after a programmed change in mode.[2] There remained the possibility that adaptation by the ventricle during a prolonged period of ventricle inhibited pacing would remove the difference in exercise capacity. In this issue of the journal, Perrins and his colleagues at the Westminster Hospital (p.112) confirm, by means of a randomised controlled trial, that the difference in exercise tolerance is sustained. Of at least equal importance, they also show that a number of unpleasant symptoms, often present during ventricle inhibited pacing, are ameliorated during atrial synchronous pacing. The result of a recent less detailed analysis of symptoms during these two pacing modes was similar.[3] Thus, maintenance of synchrony confers a degree of benefit upon many patients even while at rest or during day to day activity.

Dual chamber, "physiological" pacemakers require circuitry which is much more complex than that of the traditional ventricular pacemaker, but provided only components satisfying rigorous selection criteria are incorporated, this complexity does not appear to reduce reliability appreciably.

At present, atrial and ventricular electrodes are introduced separately into the venous system but this requirement need not pose an insuperable or usually, indeed, serious problem since it is often possible to insert two electrodes into the same surgically exposed vein,[4] and the introduction of both leads into the subclavian vein after a single puncture is easily achieved.[5] The major impact of the increasing complexity of advanced pacemakers on the physician results from the need to predict the behaviour of the pacemaker under various conditions and to be able to interpret the electrocardiogram when unusual rhythm disturbances or pacemaker activity occur.

Unipolar atrial synchronous pacemakers will stimulate the ventricle prematurely in response to pectoral myopotentials. This undesirable feature may be minimised by the incorporation of noise sensing circuitry and will eventually be eliminated completely by the introduction of dual bipolar systems.

Dual chamber pacemakers now becoming available are of a size comparable with that of single chamber units of only a few years ago and surgical complications will be correspondingly rare. Electrode displacement, failure to capture, and malsensing still occur occasionally, but with careful implantation technique, the use of "fixation" leads, and the implantation of pacemakers with programmable output and sensing characteristics, the need for revision on these grounds will also be rare. In the author's experience actively fixed leads are seldom required and passive fixation in both atrium and ventricle with "tines" is associated with excellent results.

The development of atrial fibrillation will result in deceleration or acceleration of the pacemaker depending on the magnitude of the fibrillary electrograms. Of considerable concern has been the occurrence, some-

times unpredictable, of pacemaker re-entrant tachycardia. Retrograde conduction via the atrioventricular node or other pathway may result in the development of a circus movement tachycardia which depends upon the pacemaker for anterograde conduction. This phenomenon has limited the application of physiological pacemakers to patients with incomplete atrioventricular block, though, as Perrins and co-workers state, it may occur even in the absence of anterograde intracardiac conduction. Future developments in pacemaker design are likely to eliminate pacemaker tachycardia as a serious clinical problem.

Because of the possibility of rhythm disturbance involving the "physiological" pacemaker, the implanting physician or surgeon carries a responsibility to select pacemakers which can be programmed to perform safely under all foreseeable conditions, and to programme the units appropriately, bearing in mind the particular circumstances of each patient. Greater safeguards against tachycardia are, for example, required in the patient with severe ischaemic heart disease or a previously unstable atrial rhythm than in the otherwise fit individual.

Inevitably the cost differential between "physiological" pacemakers and non-programmable ventricular units (currently the factor is greater than two) must make an impact on the choice of system. A proportion of the difference is, however, likely to be temporary, since it is magnified by the low cost of some obsolescent models in contrast to the high price of recently developed hardware, including both pacemakers and associated programmers.

The conclusion reached by Perrins and his colleagues that physiological pacing should be considered for all suitable patients presenting with atrioventricular block is inescapable. Yet some of those responsible for implanting pacemakers may wonder how often there is a real need to use advanced pacing modes. Must all implanting physicians (and surgeons) as yet unfamiliar with "physiological" pacing acquire the necessary skills now? The answer is undoubtedly in the affirmative.

An important minority of patients with symptomatic bradycardia will remain moderately or severely symptomatic if simple ventricular pacing is used, as Perrins and co-workers point out. These patients may undergo secondary conversion to dual chamber pacing, but a more satisfactory approach is the "prophylactic" implantation of atrioventricular sequential pacemakers, with or without atrial triggering, in most patients with carotid sinus syndrome and in many with sinoatrial disease.

The recent observation (admittedly from a non-randomised trial) that residual symptoms are quantitatively important among patients with sinoatrial disorder fitted with ventricular pacemakers and that these symptoms are much better controlled by atrioventricular sequential pacing[6] complements the message of the article in this issue.

The attainment of proficiency in dual chamber pacing leads naturally to consideration of patients with atrioventricular block complicated by severe myocardial or valvular impairment for atrial synchronous pacing. These patients can be predicted to experience symptoms of decompensation on minimal activity if only the ventricles are paced, and they will benefit both from the increased cardiac output and reduction in pulmonary venous, relative to left ventricular end-diastolic, pressure resulting from maintenance of atrial transport function. Other patients who will particularly appreciate the improved haemodynamics are those whose occupation or leisure pursuits are physically exacting.

To many it will follow that both atrial and ventricular electrodes should be implanted as a routine in the younger adult patients, even when a single chamber pacemaker is to be implanted initially, since it is likely that such patients will eventually have "physiological" pacemakers substituted for their initial units.

The presence of symptomatic ischaemic heart disease demands that the selected pacing mode should result in optimal efficiency of oxygen usage, such as is afforded by maintenance of the normal atrioventricular sequence.[7] Excessive bradycardia, whether spontaneous or drug induced, exacerbates anginal symptoms, and some patients derive sustained benefit from pacing.[8] Where atrioventricular block is the mechanism of bradycardia in a patient with angina deliberate limitation, by programming, of the maximum atrial rate which the ventricles are permitted to follow is a useful therapeutic manoeuvre.[2]

The need for physiological pacing cannot always be foreseen. Any paced patient may at some time meet with a serious accident, suffer a haemorrhage, or require major surgery. In these and other situations survival may depend upon the available cardiac reserve, which will, of course, be greater if normal synchrony and, where possible, rate variability are maintained. These considerations are likely to gain in importance as the difference in cost between standard and advanced pacemakers falls.

Patients without atrial standstill or permanent atrial fibrillation are usually selected for dual chamber pacing by simple clinical criteria. The ability to programme the pacemaker between a variety of modes and to alter other characteristics non-invasively after implantation almost eliminates the need for detailed preliminary laboratory evaluation. Retrograde conduction is invariably assessed during implantation and, if required, anterograde intracardiac conduction times may also be measured at the same time.[9]

Recently, the variations in QT interval of the paced ventricular complex resulting from changes in sympathetic nervous activity, and sensed via the pacing electrode, have been used to determine the rate of firing of a ventricle inhibited pacemaker.[10] In its present form, this technique offers the possibility of rate variability and a greatly increased potential for raising cardiac output on exercise without increasing the complexity of the implantation procedure, and it is the only available means of providing physiological rate change for patients with atrial fibrillation.

It is too early to estimate the degree to which the ventricle inhibited rate responsive pacemaker will relieve symptoms in a broad cross-section of patients. Possibly a "hybrid" form which enables atrial synchrony to be maintained, when possible, will emerge.

The small percentage of patients for whom currently conventional pacing techniques are blatantly unsatisfactory clearly represents the tip of yet another iceberg whose true dimensions the work of Perrins and his colleagues has done much to delineate. It may be some time before those who implant pacemakers will find it practicable to provide the majority of suitable patients with "physiological" units. It is, however, appropriate to bear in mind that a normal atrioventricular sequence and variability of heart rate are much more "conventional" than the situation obtaining during ventricle inhibited pacing. The phased application of this new advance will improve the quality of life for many patients at a modest annual increase in cost.

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