THE VALUE OF THE ATRIAL PACING TEST

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The atrial pacing test was performed on 62 subjects—10 fit medical students, 15 patients with proven coronary artery disease and 37 patients referred for the elucidation of equivocal chest pain. Forty-nine of those studied were also subjected to a supine bicycle exercise test. The atrial pacing test appeared superior in regard to success rate, reproducibility and safety. Some disadvantages of both tests, hitherto ignored, are discussed. The phenomenon of the long P-R interval occurring at medium pacing rates was seen more frequently in the normal subjects and in those patients without coronary artery disease, in contrast to previously published work.

The atrial pacing test has been used in various centres as a test for angina since the original reports of Balcon et alii (1968, 1969) and Friessinger et alii (1967). In this paper, we compare the efficacy of the atrial pacing test and supine bicycle exercise test in 10 normal subjects and in a group of patients with proven coronary artery disease. We also present a clinical evaluation of the technique as a test for coronary artery disease (Lau et alii, 1967; Sowton et alii, 1967) in a group of patients with atypical chest pain.

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METHODS AND MATERIALS

Sixty-two subjects were studied, and the method was fully explained to each. There were 10 healthy medical students who volunteered for both tests. There were 15 patients with known coronary artery disease, as shown by a previously documented myocardial infarction or by an abnormal resting electrocardiogram associated with exertional chest pain. The group of patients with equivocal chest pain had normal resting ECG's, but had complained of atypical pain in the chest or in the epigastrium. All patients with congestive cardiac failure, hypertension or known heart disease other than coronary artery disease were excluded.

The exercise tests were carried out with the patient supine, by means of an "Elena" bicycle ergometer. The recordings were made on a "Telechronic" hot stylus recorder at paper speeds of 25 and 50 mm/sec, using disposable electrodes applied to the shoulders and costal margins for the limb lead positions, together with the usual V2, V4, V5 and V6 chest leads. ECG's with the patient standing and supine were recorded before exercise (Epstein et alii, 1969). The exercise test was graded starting at 50 watts and increasing in steps of 12.5 or 25 watts every 2 min. Exercise was continued until pain, ECG changes or exhaustion occurred or until a heart rate of 90% of the maximum predicted for the patient's age was reached (Kriststad et alii, 1969; WHO Technical Report, 1969). The ECG was monitored continuously throughout, and a 10-lead ECG was taken immediately after exercise and another 2 min later.

The atrial pacing test was usually carried out on a separate occasion. The procedure was carefully explained to each subject, and no premedication was given. A bipolar 561 "End-Cath" or a No. 4 U.S.C.I. bipolar catheter was inserted percutaneously into a median cubital vein using "Feldon" introducers, and the catheter was positioned, under radiographic observation, at the junction of the superior vena cava and the right atrium. A battery-operated "361" was used to deliver the pacing impulses, and the catheter was positioned to produce sufficient pacing as observed on the monitor. The criteria of positivity were the occurrence of chest pain or the development of significant R-T depression (WHO Technical Report, 1969; Laposhkin and Surwczik, 1958). A further measurement of the S-T depression was made by averaging the area over the depressed S-T segment in five consecutive QRS complexes. This was termed the "negative S-T integral" after the method of Sheffield et alii (1969).

RESULTS

Difficulties, which seem to have received little attention in other published work, were experienced with both the exercise test and the atrial pacing test. In the bicycle test we found that with elderly patients, particularly females, aching legs and inability to continue pedalling stopped the test before an adequate heart rate was achieved. Furthermore, two of our six young medical students failed to reach a heart rate of over 155 per minute even after 10 minutes of maximal exercise. Either test was therefore regarded as a failure if, for any reason, an adequate apex rate was not reached. The high failure rate in the exercise test was due to our rigid criterion requiring 90% of the maximum predicted heart rate to be achieved.

In the atrial pacing test there were four main difficulties.

1. Failure to enter the cubital vein (5 out of 62). This necessitated either antecubital cut-down or the use of the percutaneous femoral approach.

2. Intermittent atrial capture. This was dependent on the position of the catheter, contact with the atrial wall being an advantage, and so the stiffer U.S.C.I. catheter was found to be the more satisfactory instrument.

3. Phrenic nerve stimulation causing contraction of the right hemidiaphragm. This was easy to deal with by repositioning the catheter; but because it feels uncomfortable, the patient should be warned of the possibility of its occurrence.

4. The appearance of a very long P-R interval causing atrio-ventricular block of the Wenckebach type progressing to 2:1 atrio-ventricular block (Figure 1, A). Unlike other reports (Lister et alii, 1965; Leon et alii, 1970), we found this phenomenon in all our normal young men, and in all but two of our patients with atypical pain and a negative response to the pacing test. The atrio-ventricular block caused inability to pace the heart at rates above 150/min. To circumvent this, 1/2 mg of atropine were given intravenously to all patients who showed the long P-R phenomenon (Figure 1, B and C). By the use of this drug, which rapidly shortens the P-R interval, we were able to achieve 90% of the predicted heart rate for age in all but two of our subjects, but even with atropine we were unable to pace these two normal subjects at rates over 150/min. Measurement of the negative S-T integral (Sheffield et alii, 1969) was found to be a useful adjunct in the determination of significant S-T depression.

![Figure 1: A: The Wenckebach phenomenon developing in a normal subject paced from the right atrium at 120/min. B: A normal subject paced at 120/min; the P-R interval is 0.34 sec; C: The same subject at the same pacing rate, after the administration of atropine; the P-R interval is 0.24 sec. (The voltage change is due to the recording instrument.)](image-url)
and the results were found to correlate well with E-T depression measured by the standard method (WHO Technical Report, 1968; Lepeschkin and Suralwicz, 1968). Tables 1 and 2 show that out of 10 normal males, eight gave negative responses to the pacing and exercise tests, two different subjects failing to reach the required heart rate in each test. All patients who had coronary artery disease gave positive results to the pacing test, but of those who were exercised, half failed to achieve an adequate heart rate. The anginal threshold of those with a positive response to the exercise test was 10 to 20 beats per minute lower than the anginal threshold determined by pacing (Balcian et alii, 1969).

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Positive Response</th>
<th>Negative Response</th>
<th>Test Failed</th>
<th>Exercised</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal subjects</td>
<td>8</td>
<td>2</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patients with coronary artery disease</td>
<td>7</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>15</td>
</tr>
<tr>
<td>Patients with equi-vocal chest pain</td>
<td>6</td>
<td>13</td>
<td>9</td>
<td>9</td>
<td>37</td>
</tr>
</tbody>
</table>

Atrial pacing was successful in all patients with equi-vocal chest pain, and 14 of these gave a positive result. Twenty-eight out of the 37 were exercised, but only six showed a positive result, and nine failed to achieve an adequate heart rate with exercise. No patient giving a positive result to the pacing test gave a negative result to the exercise test, but the high failure rate of the exercise test was a serious disadvantage.

**DISCUSSION**

In our series, the atrial pacing test emerges as a satisfactory test with a higher success rate and clearer results than the supine exercise test. Furthermore, we consider it to be safer, because the angina can be terminated quickly by reducing the pacing rate, whereas with exercise, pain and stress may continue for some minutes after exercise has stopped. The only side effects noted were in two patients who developed transient atrial arrhythmias with a slow ventricular response, which reverted spontaneously to sinus rhythm within 30 seconds (Haft et alii, 1968). In our study, the development of a long P-R interval occurred in a different group of patients from those described by previous authors. We found this to occur in the normal adults and in those without coronary artery disease, whereas others have reported the opposite. Atropine was necessary in all these cases to decrease the P-R interval, and to achieve a sufficiently rapid heart rate to ensure that acceptable stress was applied to the cardio-vascular system.

**REFERENCES**


Telly doctors are always answering demands for visits on the 'phone and saying they'll come right away. They always know where to go and don't drift up and down roads where the name has been knocked off and none of the houses has a number—usually in the dark at that—using a hand torch and cursing a blue streak at anything or anyone. It's not the way real doctors do. There's always somewhere to park. In life there never is and he may have to park half a mile away. If the visit is in a high block of council flats—which it never is—you never see him climbing up the wrong block because the teenagers have put the lifts out of order. Just climbing stairs is not interesting viewing. You don't see the room where the patient is fully dressed and enjoying the drama with the neighbours in as an audience, and the radio and telly on, not to speak of the dog nibbling at your calf. . . . Telly medicine is never like that and if you were to show it the way it is, everyone would switch off.—C. Swan, "Box Doctors", Wld Med., 1970, 6: 31 (November 25).