THE EFFECTS OF HEXAMETHONIUM IODIDE ON THE ELECTROCARDIOGRAPH IN ANÆSTHETIZED SUBJECTS

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Electrocardiographic recordings during and after the use of hexamethonium have already been reported. Thus, James (1953) and his co-workers have taken electrocardiographs before, during and after hypotension produced by hexamethonium; they found no suggestion of myocardial ischaemia. Wyman (1953) found frequent but transient post-operative T wave changes after the use of hexamethonium.

The present investigations were carried out to determine if any immediate changes in cardiac function could be demonstrated electrocardiographically following the intravenous injection of hexamethonium iodide.

SUBJECTS

Forty patients were studied, all of whom were undergoing ear, nose and throat operations. All were fit and healthy apart from their local condition and their ages ranged from fourteen to sixty-eight years; a detailed analysis is given in Table I.

TECHNIQUE

The premedication in patients under eighteen and over sixty years was morphia gr. 1/6 (10 mg.), atropine gr. 1/100 (0.65 mg.), the remainder received papaveretum gr. 1/3
The Effects of Hexamethonium Iodide

TABLE I

<table>
<thead>
<tr>
<th>Decade</th>
<th>No. of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>11-20</td>
<td>11</td>
</tr>
<tr>
<td>21-30</td>
<td>14</td>
</tr>
<tr>
<td>31-40</td>
<td>6</td>
</tr>
<tr>
<td>41-50</td>
<td>4</td>
</tr>
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<td>51-60</td>
<td>3</td>
</tr>
<tr>
<td>61-70</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
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</table>

(20 mg.), scopolamine gr. 1/150 (0.45 mg.). On the arrival of the patient in the anaesthetic room an electrocardiograph record was made using the standard leads in order to give the normal (pre-operative) resting tracing and, at the same time, the resting blood pressure was determined by auscultation.

In the operating theatre the patient was anaesthetized, the technique used depending on the operation to be performed. Intubation was carried out in all cases the tube being well lubricated with 10 per cent cinchocaine cream. When it was quite certain that the patient had “settled” under the anaesthetic another electrocardiograph was taken and once more the blood pressure was determined. The table was then tilted to 20 degrees of anti-Trendelenburg tilt, and further electrocardiographic and blood pressure records were made.

The requisite dose (see below) of hexamethonium iodide was now given via a Gordh needle into one of the forearm veins, the injection being carried out rapidly. Immediately the injection was completed the electrocardiographic recordings were recommenced and the tracing was continued until auscultation showed that the blood pressure was no longer falling rapidly. Katz (1946) has pointed out the need to standardize the electrocardiograph for every
new position the patient adopts; it will be seen that in this work the electrocardiograph taken after the injection of hexamethonium iodide can be compared with that taken under the anaesthetic alone, after tilting, and with the normal resting record. Leads 1 and 2 were each used for the theatre tracings in twenty cases. The interval between the time when the patient was tilted and the beginning of the post-hexamethonium tracing varied a little in different cases, but was about three minutes.

The electrocardiogram was controlled by the same operator throughout this investigation. All the anaesthetics were administered, and the blood pressure taken, by one of the writers (M.S.).

Anaesthetic

As has been stated above, the type of anaesthetic depended primarily on the nature of the operative procedure about to be performed. In fourteen cases the anaesthetic used was nitrous oxide-oxygen-ether administered by semi-open circuit using a Boyle’s machine. The other twenty-six patients were induced with 8–10 ml. of 5 per cent sodium thiopentone solution, and the cords were then sprayed under direct vision with 2 per cent lignocaine solution before intubation. Anaesthesia was maintained by nitrous oxide-oxygen (5 litres: 2 litres) in a semi-open circuit, with thiopentone supplements. No other anaesthetic agents were used until after the electrocardiographic recordings had been completed. Anoxia was, of course, avoided throughout.

Hexamethonium

The dose of hexamethonium iodide administered in each case was based on a consideration of:

(1) The blood pressure change produced by tilting and
by the thiopentone (in those patients who received this drug).

(2) The age and pre-operative blood pressure of the patient.

Twenty-three patients received 150 mg. of hexamethonium iodide, eleven were given 100 mg., while six received a dose of 50 mg.

Pre-operative Electrocardiographs

All the tracings taken in the anaesthetic room prior to anaesthesia were normal, but in twelve cases there was an arrhythmia present and, of these, three showed premature ventricular beats, two had a sinus tachycardia and seven exhibited sinus arrhythmia.

RESULTS

The main changes which are noticed on reading the experimental electrocardiographs are an alteration in the rate, and changes in the P wave and P-R interval.

Alteration in Rate

Twenty-four cases (60 per cent) showed a change in heart rate after hexamethonium. Table II gives an analysis of these cases. It must be remembered that the tracing was commenced immediately after the completion of the injection of hexamethonium and was continued for an average of ninety seconds.

<table>
<thead>
<tr>
<th>Change in rate</th>
<th>Type</th>
<th>No. of patients</th>
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</thead>
<tbody>
<tr>
<td>Acceleration</td>
<td>Immediate</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Delayed*</td>
<td>9</td>
</tr>
<tr>
<td>Deceleration</td>
<td>Immediate</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Delayed*</td>
<td>2</td>
</tr>
</tbody>
</table>

* The change in rate was not present at the commencement of the post-hexamethonium tracing but appeared after a number of seconds; in several cases the change in rate gradually became more marked.
Alteration in P-R Interval

The post-hexamethonium tracings frequently showed a diminution in the P-R interval which varied from a slight reduction to a complete absence, when the P wave is found buried in the up-stroke of R and then disappears. In 14 cases (35 per cent) the administration of hexamethonium caused this complete but transient disappearance of the P wave, and figure 1 shows a tracing which is typical of these cases. The disappearance of the P wave bore no apparent relationship to the dose of hexamethonium given, to the degree of hypotension produced or to the nature of the anaesthetic administered in the particular case.

Alteration of the P wave has also been seen not only after hexamethonium injection but in six of the tracings after tilting. Of these six, four showed a complete absence of the P wave (fig. 2) whilst in two the P wave became less well defined. Tilting did not produce a change in the P wave in any patient who did not show subsequently a disappearance of the P wave after hexamethonium. However, in one case the P wave became poorly defined in the post-anaesthetic tracing, but was quite normal in the records obtained after tilt and after hexamethonium injection.

In order to illustrate the changes in rhythm that may occur under anaesthesia and after tilting we include figure 3, which is the electrocardiograph of a girl of 24 years who had recently recovered from sub-acute bacterial endocarditis. There was no evidence of cardiac enlargement or stress, and she had signs of mitral valvular disease. She was anaesthetized with nitrous oxide-oxygen-ether, tilted and given 150 mg. of hexamethonium iodide intravenously. There was no immediate fall in blood pressure. The electrocardiograph showed that a nodal tachycardia developed under anaesthesia, and this changed to auricular
A. H., male, aged 34
(a) Record under anesthesia. Normal rhythm (lead 1).
(b) Bed tilted. Normal rhythm (lead 2).
(c), (d), (e), Hexamethonium iodide injected. Narrowing of PR interval well shown, followed by disappearance and then return of P waves (lead 2).
FIG. 2

G. D., female, aged 30 (lead 2 throughout).
(a) Record under anaesthesia. Normal rhythm.
(b) P waves absent after tilting (standardization deflection in middle of record).
(c), (d) Hexamethonium iodide injected. P waves return.

FIG. 3

S. R., female, aged 24 (lead 2 throughout).
(a) Normal rhythm. Resting record.
(b) Nodal tachycardia under anaesthesia.
(c) Bed tilted. Auricular tachycardia.
(d) Hexamethonium iodide injected. Sinus rhythm returns after 9 seconds.
tachycardia after tilting. The P waves returned to normal nine seconds after hexamethonium was administered.

**Blood Pressure Changes**

The alteration in blood pressure produced by hexamethonium iodide in the tilted and anaesthetized subject showed considerable variation in the 40 patients studied here. Four cases showed a rise in diastolic pressure of between 15 and 20 per cent, and in a further 2 cases the diastolic pressure did not change. In 3 patients the diastolic pressure became unrecordable. In the remaining 31 subjects there was a fall ranging from 8 to 50 per cent of the pre-hexamethonium diastolic level, the average fall being 29 per cent.

**DISCUSSION**

Of the electrocardiographic changes which we have recorded after the intravenous administration of hexamethonium iodide none can be considered specific to this drug. The alteration in rate has been observed without the injection of hexamethonium and is not related to the fall in blood pressure consequent upon the administration of this drug. The disappearance of the P wave and shortening of the P-R interval have been seen not only following the injection of hexamethonium but also after tilting of the anaesthetized subject alone. Such tilting of the patient under anaesthesia may alter the vasomotor tone, and this could account for the P wave changes. The diminution in the P-R interval was not constantly seen after hexamethonium injection and, moreover, it was frequently produced by tilting alone. It is not related to the subsequent fall in blood-pressure or to tachycardia and is presumably a vagal depressant effect.

Despite the large dosage used the changes in P wave and in P-R interval noted in this investigation were, in every
case, short lived. All the records indicate that no structural myocardial changes occur consequent upon the injection of hexamethonium iodide.

SUMMARY

(1) In 40 subjects electrocardiographic recordings were taken (a) in the resting state before anaesthesia, (b) after induction of anaesthesia, (c) after the patient had been placed in a position of 20 degrees reverse Trendelenberg tilt, (d) after the intravenous injection of hexamethonium iodide.

(2) The tracings after hexamethonium injection in some cases showed a change in rate and a transient alteration in the P wave and P-R interval. Similar changes were seen in some cases after tilting alone.

(3) There was no electrocardiographic evidence of structural myocardial change consequent upon the use of hexamethonium iodide.

ACKNOWLEDGMENTS

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REFERENCES