Electrocardiographic Changes During Gastric Hypothermia

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The electrocardiographic effects of ingesting cold and warm liquids were first recorded by Wilson and Finch in 1923. Using the three standard bipolar limb leads, electrocardiographic records were made before and at frequent intervals after six normal human subjects ingested about 600 ml. of iced water. The primary change, transiently increased negativity of the T wave in Leads II and III, was attributed to the retarded rate of repolarization induced by cooling the postero-inferior surface of the apex of the left ventricle which had been in contact with the distended fundus of the stomach. Conversely, electrocardiographic patterns were unaffected when the subjects drank equal quantities of warm lemonade.

Observations were similar when Dowling and Hellerstein used unipolar limb and precordial leads and repeated Wilson and Finch's experiment in 1951. Primary changes included increased negativity or decreased positivity of the T wave in aVF, Lead II, Lead III, and the left posterolateral chest leads; increased positivity or decreased negativity of the T wave in aVR, aVL, and the precordial leads on the right side. Maximal changes in the electrocardiogram occurred within five minutes following ingestion of the iced water and subsided completely within 25 minutes.

In view of the electrocardiographic changes demonstrated in these studies concerning the effects of drinking iced water, a procedure such as gastric hypothermia would be expected to produce similar or even more marked alterations. Early reports concerning gastric hypothermia listed no electrocardiographic changes. When our initial investigations of the effectiveness of hypothermia to suppress gastric secretion in experimental animals and in man indicated that the electrocardiogram was influenced quite frequently, a detailed study of the electrocardiographic changes which accompanied various degrees of gastric hypothermia was begun.

Material and Methods

At the Scott and White Memorial Hospital during a period from January, 1963 to May, 1964, 120 patients with roentgenologically proved duodenal ulcers and gastric hypersecretion were subjected to gastric hypothermia. This group, which serves as the clinical material for this report, consisted of 96 men and 24 women. The average age of the men was 48 years, with an age range of from 18 to 71 years. The average age of the women was 50 years. Their ages ranged from 32 to 70 years.

Procedure of Gastric Hypothermia. Using a gastric cooling unit, the technique of gastric hypothermia as described by Wangensteen and associates was employed. Thirty minutes prior to the procedure, each patient received atropine (0.04 mg.) and sodium luminal (130 mg.), intramuscularly. The volume of the coolant within the intragastric balloon varied from 600 to 900 ml. The duration of the procedure was 50 minutes.

For this study, the 120 patients were divided into three groups, classified according to the degree of hypothermia employed. In Group I, 60 patients, the temperature of the coolant as it left the hypothermia unit was -17° C. to -20° C., providing

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Supported in part by Grants (AM 07932-01 and AM 07538-01) from the National Institutes of Health.

**Swenko Company, Minneapolis, Minnesota.
a temperature of $-10^\circ$ C. as the coolant returned from the gastric balloon to the hypothermia machine. For the 31 patients in Group II, the temperature was $-5^\circ$ C. when it returned from the balloon; and for the 29 patients in Group III, the temperature was $0^\circ$ C.

Electrocardiographic Monitoring. Prior to gastric hypothermia, a routine, standard electrocardiogram was recorded for each patient; and, with the patient in a semi-sitting position, a second or control electrocardiogram was recorded before intubation.† Immediately after intubation, another electrocardiogram was made, and additional tracings were taken every minute for the first five minutes of the gastric hypothermia procedure. Because sudden changes in the cardiac rate or rhythm were the primary concern during this early stage of hypothermia, limited leads (usually Leads I and $V_4$) were taken at such frequent intervals. Subsequent tracings were recorded at 10, 15, 30, and 45 minutes during the 50 minute procedure. Initially, Leads I, II, III, $aVR$, $aVL$, $aVF$, and $V_1$ through $V_9$ were recorded; however, after all V leads failed to demonstrate additional changes in the electrocardiograms of the first patients, only one precordial lead, $V_4$, was selected in the majority of instances. Immediately after extubation, electrocardiographic tracings were continued until the control pattern returned.

†As recommended by Wangensteen and his associates.⁴

For the 120 patients, the electrocardiographic tracings were classified into four grades.

Grade I—Normal electrocardiographic pattern, without changes.

Grade II—Minimal changes. (Alterations usually consisted of an upright T wave becoming flat, or a flat T wave becoming negative.)

Grade III—Moderate changes. (An upright T wave becoming completely negative.)

Grade IV—Marked changes. (Shifting of the ST segment plus T wave changes.)

RESULTS

In our series of 120 patients who underwent gastric hypothermia, 92 (77 per cent) demonstrated electrocardiographic changes. It was interesting to note that approximately the same percentage of patients in each treatment group showed some alterations in their tracings: Group I (return temperature $-10^\circ$ C.), 78.4 per cent; Group II (return temperature $-5^\circ$ C.), 74.2 per cent; and Group III (return temperature $0^\circ$ C.), 75.9 per cent (Table 1).

When electrocardiographic changes occurred, they varied from minimal to marked, and the severity of the alteration appeared to be related to the degree of hypothermia employed (Table 2). The most common change was flattening or inversion of the T wave in Leads III and $aVF$ (Fig. 1). Our findings were similar to

<table>
<thead>
<tr>
<th>Group</th>
<th>Return Temperature</th>
<th>Number Patients</th>
<th>Without Changes</th>
<th>With Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Number</td>
<td>Per Cent</td>
<td>Per Cent</td>
</tr>
<tr>
<td></td>
<td>Temperature</td>
<td>Patients</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group I</td>
<td>$-10^\circ$ C.</td>
<td>60</td>
<td>13</td>
<td>21.6</td>
</tr>
<tr>
<td>Group II</td>
<td>$-5^\circ$ C.</td>
<td>31</td>
<td>8</td>
<td>25.8</td>
</tr>
<tr>
<td>Group III</td>
<td>$0^\circ$ C.</td>
<td>29</td>
<td>7</td>
<td>24.1</td>
</tr>
</tbody>
</table>

Table 2—Electrocardiographic Changes During Gastric Hypothermia

<table>
<thead>
<tr>
<th>Return Temperature</th>
<th>Number Patients</th>
<th>Grade II Minimal Changes (Per Cent)</th>
<th>Grade III Moderate Changes (Per Cent)</th>
<th>Grade IV Marked Changes (Per Cent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>$-10^\circ$ C.</td>
<td>47</td>
<td>40.5</td>
<td>57.5</td>
</tr>
<tr>
<td>Group II</td>
<td>$-5^\circ$ C.</td>
<td>23</td>
<td>42.4</td>
<td>52.2</td>
</tr>
<tr>
<td>Group III</td>
<td>$0^\circ$ C.</td>
<td>22</td>
<td>72.9</td>
<td>27.7</td>
</tr>
</tbody>
</table>
those reported recently by Karacadag and Klotz and Balart and his co-workers.

The more marked electrocardiographic changes were noted from 30 to 45 minutes after the procedure was begun; and, in all but one patient, the pretreatment electrocardiographic pattern returned within ten minutes after the procedure ended. In three of our patients, sinus tachycardia (140 to 150 beats per minute) developed shortly after intubation, but disappeared in less than four minutes. One of these patient's tracings also revealed intermittent coronary sinus rhythm. In four other patients, premature ventricular contractions occurred occasionally, but these contractions disappeared shortly after the procedure was completed. Atrial fibrillation, as reported by Reynolds and Scherl, was not observed.

**SPECIAL PROBLEMS**

In addition to the electrocardiographic changes which were observed in these patients, two patients (Group I) experienced a peculiar form of vascular collapse during the procedure of gastric hypothermia.

A woman, aged 60 years, was intubated without difficulty. The gastric balloon was filled with 800 ml. of coolant, and the procedure was begun. Shortly after the outflow temperature fell below 0°C., she developed pain in her upper abdomen. The pain extended through to her back. Her blood pressure dropped from 122/80 to 84/66; and her pulse became almost im-

**ELECTROCARDIOGRAPHIC CHANGES DURING GASTRIC HYPOTHERMIA**

![EKG Tracings](image)

**FIGURE 1:** Typical electrocardiographic changes in a 39-year-old man before, during, and after gastric hypothermia.
perceptible. She became pale and unresponsive for a few seconds. Immediately, the gastric balloon was emptied. Gradually, her blood pressure and pulse rate returned to normal limits; the abdominal pain disappeared and she felt better. During this episode, only minimal electrocardiographic changes were observed. When the balloon was refilled with 650 ml. of coolant, the procedure could be continued for only 40 minutes because of the patient's anxiety and apprehension.

In another patient, a 49-year-old man, hypothermia was discontinued at 35 minutes because of a sudden and significant drop in blood pressure accompanied by electrocardiographic changes which were suggestive of posterolateral myocardial ischemia. The patient denied thoracic or abdominal pain. Vasopressor agents were necessary for approximately eight hours to maintain an adequate blood pressure level. After 24 hours, the electrocardiographic pattern returned to normal. Serial serum transaminase levels remained normal.

Only one of our patients (Group I) had a history of myocardial infarction. This patient, a 68-year-old man, had experienced a posterior myocardial infarction nine years previously, and hypertension had been present for four years. Although electrocardiographic evidence of the previous infarction was present at the time of the procedure, gastric hypothermia was performed without complications—the electrocardiogram remaining unchanged. Twelve days after gastric hypothermia, however, the patient was hospitalized in his home town because of massive hemaatemesis and melena. An electrocardiogram recorded a few hours after his admission to the hospital was reported as being within normal limits. Two units of blood were prescribed; but while the patient was receiving the second transfusion, he expired suddenly. A postmortem examination revealed that the right coronary artery was totally occluded by recent thrombi. Examination of the stomach showed a large area of superficial ulceration along the greater curvature.

**Summary**

Electrocardiographic changes were demonstrated in 92 (77 per cent) of 120 patients who received gastric hypothermia for duodenal ulcer, the most common change being depression or inversion of the T wave. In all but one of these patients, the alterations were transient in nature, returning to the prehypothermia pattern within ten minutes after the procedure was terminated.

When the 120 patients were divided into groups according to the degree of hypothermia employed for treatment, the percentage of patients showing electrocardiographic changes in each group was essentially the same: Group I (return temperature \(-10^\circ\text{C}\.\)), 78.4 per cent; Group II (return temperature \(-5^\circ\text{C}\.\)), 74.2 per cent; and Group III (return temperature \(0^\circ\text{C}\.\)), 75.9 per cent. The degree of alteration of the electrocardiographic pattern appeared to be related to the degree of hypothermia used with the more severe changes being observed in Groups I and II.

In addition to electrocardiographic changes, two patients experienced a peculiar drop in blood pressure. Vasopressor agents were necessary to restore normal blood pressure in one of these patients.

**Resumen**

En 120 casos de úlcera duodenal que fueron tratados por hipotermia se observaron cambios electrocardiográficos en 92 (70%), siendo el más corriente la depresión o inversión de la onda T. En todos menos uno estas alteraciones fueron de naturaleza transitoria, con restauración de la norma prehipotérmica dentro de los diez minutos siguientes a la terminación del procedimiento.

Si de dividir estos 120 casos en grupos basados en el grado de hipotermia obtenido el porcentaje de cambios observados en cada grupo permanece prácticamente invariable: Grupo I (temperatura de retorno \(-10^\circ\text{C}\.\)), 78.4%; Grupo II, (temperatura de retorno \(-5^\circ\text{C}\.\)) 74.2%; Grupo III, (temperatura de retorno \(0^\circ\text{C}\.\)) 75.9%. El grado de alteración en el trazado electrocardiográfico parece estar en relación con el grado de hipotermia empleado, siendo los más marcados los observados en los grupos I y II.

Además de los cambios electrocardiográficos, dos de los sujetos estudiados presentaron una baja significativa de la presión arterial, habiendo
ECG CHANGES DURING GASTRIC HYPOTHERMIA

501

Teilt man die 120 Patienten in Gruppen entsprechend dem Grad der für die Behandlung verwandten Hypothermie, so waren die Prozentzahlen derjenigen Kranken, die elektrokardiographische Veränderungen aufwiesen, bei jeder Gruppe im wesentlichen die gleichen: Gr. I (Rückkehr-Temperatur -10°C), 78,4 %, Gr. II (Rückkehr-Temperatur -5°C), 74,2 %, und Gr. III (Rückkehr-Temperatur 0°C) 75,9 %. Der Grad der Alteration des elektrokardiographischen Kurvenablaufs scheint in Beziehung zum Grad der Hypothermie zu stehen, die verwandt wurde, in dem doch die schwereren in Gruppen I u. II beobachteten wurden.

Zusätzlich zu den elektrokardiographischen Veränderungen kam es bei 2 Patienten zu einem ausgesprochenen Blutdruckabfall. Es waren Vasopressoren erforderlich, um bei einem von ihnen den Blutdruck wieder zu normalisieren.

REFERENCES

For reprints, please write: Scott and White Memorial Hospital, Temple, Texas.

I131 IN CORONARY ATHEROSCLEROSIS

1131 peanut oil may replace 131 tritoll and with satisfactory results in clinical use. The results of lipid metabolic measurements with 1131 peanut oil in 50 cases of coronary atherosclerosis, ten cases of aortic atherosclerosis and 15 cases of hypercholesteremia are reported. Forty-eight of 50 cases of coronary atherosclerosis showed abnormality in the 1131-labelled lipid metabolism test (96 per cent). The authors are led to believe that the 1131-labelled lipid metabolism test appears to be more sensitive than the chemical estimations of blood lipids in reflecting the state of lipid metabolism. It is proposed that the number of blood samples taken could be reduced from seven to two, at three and 24 hours after ingestion.