HYPOTHERMIA

APPRAISAL OF RISK IN 110 CONSECUTIVE PATIENTS

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(Received for publication May 15, 1962)

Direct surgical attack of intracranial aneurysms, utilizing occlusion of arterial inflow during hypothermia, appears to offer the best hope for a complete cure.\textsuperscript{1,6,7} It must be pointed out that because of our relative ignorance of morbidity and mortality solely or primarily related to total-body hypothermia, hypothermia has not been refused to any patient on any ground. Our experience with this particular problem now numbers 110 patients.

The author will not presume to evaluate the over-all results or the curative value of surgery; rather an attempt will be made to give as satisfactory an answer as possible to the following question: Assuming that surgery under hypothermia is technically the best way to attack these lesions, then what is the additional risk to which the patient is exposed because of the use of hypothermia?

MATERIAL AND METHODS

A general breakdown of all cases by age, sex, type of lesion, lowest body temperature achieved, incidence of hypotension, acidosis, electrocardiographic abnormalities and death rate is given in Table 1.

\textbf{TABLE 1*}

\textit{All patients}

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>0–10</th>
<th>10–20</th>
<th>20–30</th>
<th>30–40</th>
<th>40–50</th>
<th>50–60</th>
<th>60–70</th>
<th>70+</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>11</td>
<td>11</td>
<td>44</td>
<td>28</td>
<td>9</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Sex</td>
<td>Male</td>
<td>Female</td>
<td>70</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disease</td>
<td>Aneurysm</td>
<td>90</td>
<td>Tumor</td>
<td>4</td>
<td>A.V. anomaly</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lowest body temperature</td>
<td>26°C. or less</td>
<td>8</td>
<td>26°–28°C.</td>
<td>61</td>
<td>28°–30°C.</td>
<td>30</td>
<td>Over 30°C.</td>
<td>11</td>
</tr>
<tr>
<td>Hypotension</td>
<td>Yes</td>
<td>91</td>
<td>No</td>
<td>19</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acidosis</td>
<td>Moderate</td>
<td>25</td>
<td>Marked</td>
<td>4</td>
<td>No acidosis</td>
<td>14</td>
<td>No data</td>
<td>67</td>
</tr>
<tr>
<td>Electrocardiogram</td>
<td>Abnormalities</td>
<td>38</td>
<td>No abnormalities</td>
<td>42</td>
<td>Oscilloscope only</td>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deaths</td>
<td>26</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Lowest body temperature refers to deep or core temperature. This was measured by advancing a thermistor at least 10 cm. in the rectum, if after digital examination it proved to be free of fecal material. If feces were present and could not be evacuated then esophageal temperature was recorded.

Hypotension is defined as a fall in systolic blood pressure greater than 40 mm. Hg below pre-anesthetic levels or a systolic pressure lower than 80 mm. Hg for more than 20 consecutive min.

Mild acidosis is defined as a fall in pH of less than 0.2 of a unit and/or a fall in the value for carbon-dioxide combining power of less than 5.0 mEq./l. from control pre-anesthetic levels. Greater deviations were labeled as marked acidosis.

All patients were followed until discharged from the hospital irrelevant of duration of hospitalization. Thus “death” does not refer to death occurring within a specific interval of time or to death associated with a specific set of circumstances.
Hypothermia—Appraisal of Risk

The management of anesthesia was uniform throughout. No premedications were administered. Anesthesia was induced by the administration of intravenous thiopental and maintained by ether via a closed circle. Ventilation was never assisted nor controlled and muscle relaxants were not employed except as needed to facilitate endotracheal intubation. Hypothermia during deep ether anesthesia was induced by means of surface cooling, in general through immersion in a tub full of ice water and occasionally by covering the patient with ice cubes. This technique has been described in greater detail elsewhere.\(^5\)

For the purpose of clarity the patients under study may be divided into two main groups with reference to their general conditions at the time hypothermia was induced. In Group 1 are the patients who presented symptoms secondary to disease of the central nervous system only. In Group 2 are those patients in whom coexisting conditions, such as obesity, hypertension, chronic respiratory disease, diabetes and abnormal electrocardiographic findings, might complicate or even overshadow the primary disease of the central nervous system. The 2 patients who were pregnant at the time hypothermia was induced will be considered separately.

GROUP 1

There were 44 patients who had symptoms of disease of the central nervous system only. Age, sex, type of disease, lowest body temperature achieved, incidence of hypotension, acidosis and electrocardiographic changes and death rate are given in Table 2.

Anesthetic and Operative Course. Permanent electrocardiograms are available in 30 cases and no abnormalities can be detected in 15. A slow low-voltage wave which follows closely and impinges on the QRS complex was seen in 15 patients. This wave has been reported previously and its significance is rather obscure.\(^4,8\) Arrhythmias were noted in 3 patients: premature ventricular contractions in the first 2 and a wandering atrial pacemaker in the third patient; they were all of no clinical significance.

Hypotension was noted in 30 patients. This did not appear to be associated with the electrocardiographic disturbances or the development of acidosis. Profound hypotension by means of pharmacologic ganglionic blockade was induced uneventfully in 2 patients.

Mild acidosis was noted in 9 patients. A more marked degree of acidosis in 1 patient and a very severe case of metabolic acidosis, the only one observed in this whole study, also were noted.

Serious difficulties during anesthesia and hypothermia were encountered in 1 case only. The patient, a 56-year-old female, had been admitted in the afternoon and, after emergency angiography had confirmed the diagnosis of intracranial aneurysm, it was decided to perform immediate operation. At the time that the aneurysm was being dissected and severe traction was exerted on the brain, complete cardiac standstill occurred as documented by respiratory arrest, disappearance of the blood pressure and pulse and flattening of the electrocardiogram. The aneurysm was clipped promptly in a bloodless field and after 3'30", during which manual ventilation with a high flow of oxygen had been carried out, and after pressure on the brain had been released, the cardiac beat resumed spontaneously. The body temperature at the time of the accident was 30°C. Her recovery was complete and uneventful.

Postoperative Course. Three major complications were noted. Barbiturate poisoning was observed in 1 patient to whom excessive doses of intravenous barbiturates had been given during the rewarming period in an attempt to control severe shivering. He appeared to recover from this episode although the long-range result has been rather poor. It is impossible to say whether this is caused by the effects of the intracranial procedure or the bout of hypoxia accompanying the barbiturate depression or whether the two factors have compounded each other. In a second patient severe thrombophlebitis developed leading to a pulmonary embolism. Prompt heparinization and conventional