The Ballistocardiogram in Juvenile Diabetes Mellitus

By ROBERT E. RAKEL, B.S., THOMAS G. SKILLMAN, M.D., AND
JOHN R. BRAUNSTEIN, M.D.

Ballistocardiographic studies were made in 41 patients with diabetes since childhood. A high incidence of abnormalities was observed. The possible diagnostic and prognostic implications are discussed.

THE high incidence of arteriosclerosis in juvenile diabetes is well known. White recently reported that 88 per cent of her large series of 1072 cases had evidence of calcified arteries after 29 years of diabetes. It is evident that today vascular disease is the most important pathologic complication of the young diabetic, and that coronary atherosclerosis plays a significant part in this picture. The purpose of this report is to describe the ballistocardiographic abnormalities found in the course of juvenile diabetes mellitus. The high incidence of these abnormalities suggests the use of this tool as a possible aid in the early diagnosis of coronary sclerosis.

METHOD OF STUDY

The 41 patients comprising the group attended the Juvenile Diabetic Clinic at the Cincinnati General Hospital. All patients experienced the onset of diabetes prior to the age of 15. The mean duration of diabetes was 17.4 years, with a range of 10 to 30 years. The mean age of the group was 24.2 years, with a range of 15 to 43 years. No patient had evidence of cardiac failure. Rheumatic or congenital heart disease was not believed to be present in any case, as evidenced by history, physical examination, roentgenologic or electrocardiographic study. No patient was obese.

Ballistocardiograms were made with the patient fasting and in a rested state. The tracings were recorded on a high-frequency table-type research instrument that recorded both head-to-foot and side-to-side movements. Lead I of the electrocardiogram was recorded simultaneously on the same paper for means of coordination. Following the ballistocardiogram a standard 12-lead electrocardiogram was taken. For control data, 41 normal subjects of the same age and sex distributions were studied. The ballistocardiograms were studied for abnormalities in pattern and amplitude.

On the day of examination other studies were conducted of factors that might influence the ballistocardiogram. A complete physical examination was carried out. Roentgenologic study of the aorta and peripheral vessels was made for calcification. The fundi were examined by an ophthalmologist. The concentrations of blood sugar, serum total lipids and serum cholesterol were determined.

RESULTS AND DISCUSSION

Of the 41 patients studied, 17 (41 per cent) had abnormal ballistocardiographic patterns. Many were persistently abnormal in serial tracings taken at yearly intervals. No irregularities were found in the control group. The abnormalities found are listed in table 1. It is apparent that no single pattern predominated, and that more than 1 abnormality was usually present in a single tracing. Only 2 of the entire group of 41 patients had abnormal electrocardiograms. These 2 also had abnormal ballistocardiograms. The electrocardiographic pattern in these instances was compatible with left ventricular ischemia. The amplitudes of the complexes were also measured and compared to the criteria of normal, as determined by Starr. All normal tracings had normal amplitudes. Of the 17 abnormal tracings 12 were abnormally small and 5 were within normal limits in amplitude.

From the Cardiac Laboratory and the Metabolism Laboratory of the University of Cincinnati College of Medicine, Cincinnati General Hospital, Cincinnati, Ohio.

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In comparison of the general characteristics of the group giving normal tracings with those with abnormal tracings, no significant differences between ages, sex distributions, duration of diabetes or insulin dosage (table 2) were found.

Attempts were made to relate the ballistocardiographic changes to demonstrable vascular complications (table 3). The patients were too few to show a significantly higher incidence of retinopathy or peripheral vessel calcification. However, the incidence of arterial hypertension (sustained pressure in excess of 140/90) was significantly greater in those with abnormal ballistocardiographic patterns ($p < 0.02$). Hyperlipemia or hypercholesterolemia was not more significantly frequent in those with abnormal tracings. The mean concentrations of blood glucose were equivalent in the 2 groups.

<table>
<thead>
<tr>
<th>Type of Abnormal Pattern</th>
<th>Times Observed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abnormally small complexes</td>
<td>8</td>
</tr>
<tr>
<td>Increased transverse component</td>
<td>7</td>
</tr>
<tr>
<td>Late downstroke pattern</td>
<td>6</td>
</tr>
<tr>
<td>Increased respiratory variation</td>
<td>5</td>
</tr>
<tr>
<td>Early M pattern</td>
<td>4</td>
</tr>
<tr>
<td>Deteriorated complexes</td>
<td>3</td>
</tr>
</tbody>
</table>

Since the observations were made, 3 of the patients have died, all of whom had abnormal tracings. Autopsies performed on 2 demonstrated marked coronary atherosclerosis and interstitial fibrosis of the myocardium.

Because hyperlipemia has been reported to influence the ballistocardiogram, 4 of the patients with abnormal tracings and elevated serum lipids were studied serially at 15-minute intervals for 1 hour after the intravenous injection of 100 mg. of heparin. Two patients with normal ballistocardiograms and elevated serum lipids were also given heparin and served as controls. No alterations were found to follow heparin administration in either group.

From the above observations it appears that the abnormal ballistocardiographic findings were more prevalent in those with hypertension. It is most likely that the abnormalities were related to the development of coronary sclerosis. The prevalence of such sclerosis is well known in the course of juvenile diabetes. Accordingly, it is possible that the ballistocardiogram will be an aid in the early diagnosis of coronary sclerosis in juvenile diabetes.

**Summary**

Ballistocardiograms were made from 41 patients with juvenile diabetes of more than 10

<table>
<thead>
<tr>
<th>Abnormalities</th>
<th>Normal (24)</th>
<th>Abnormal (17)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetic retinopathy</td>
<td>13</td>
<td>15</td>
</tr>
<tr>
<td>Arteriosclerotic retinopathy</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>Peripheral vessel calcification</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Hypertension (&gt;140/100 sustained)</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>Serum lipids &gt; 900 mg. %</td>
<td>12</td>
<td>13</td>
</tr>
<tr>
<td>Serum cholesterol &gt; 250 mg. %</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Blood glucose concentration</td>
<td>Mean</td>
<td></td>
</tr>
<tr>
<td></td>
<td>196</td>
<td>200</td>
</tr>
<tr>
<td></td>
<td>Range</td>
<td>(88-332)</td>
</tr>
</tbody>
</table>
years' duration. Seventeen (41 per cent) had abnormal patterns, 2 of whom also had abnormal electrocardiographic patterns. It is suggested that the abnormalities were related to the early development of coronary sclerosis.

**Summario in Interlingua**

Ballistocardiogrammas esseva obtenite ab 41 juveniles con diabete de plus que 10 annos de duration. In 17 (41 pro cento) le configurationes ballistocardiographic esseva anormal. In 2 del 17, etiam le configurationes electrocardiographic esseva anormal. Es opinate que le anormalitates esseva le effecto de un disveloppamento precoce de sclerosis coronari.

**REFERENCES**


Elevation of serum oxalacetic transaminase is not specific for any particular disease but depends upon a number of factors contributing to serum transaminase levels. On the other hand, glutamic-pyruvic transaminase is said to be more specific for detection of hepatocellular damage and less sensitive as an indicator of myocardial necrosis. The serum concentrations have been correlated with the enzyme concentrations in the respective tissues involved. In this report, the sera of 150 patients were compared with respect to oxalacetic and pyruvic transaminase activities to determine the value of the latter in a variety of disease states. In 24 patients with myocardial infarction the serum oxalacetic transaminase was elevated; pyruvic transaminase was elevated in some and normal in others. In patients with hepatic disease including hepatitis, cirrhosis, cancer, and hepatic necrosis and in acute pancreatic necrosis, both transaminases were elevated. Four of 5 patients with viral hepatitis had higher serum pyruvic transaminase than oxalacetic transaminase levels. The highest levels of activity were noted during the initial phase of viral hepatitis. In extrahepatic obstructive jaundice, both transaminases were elevated; slight elevations occurred in both serum enzyme levels in intrahepatic obstructive jaundice. These findings indicate that serum pyruvic transaminase is not more sensitive as an indicator of hepatocellular damage nor is it specific for this condition. The pyruvic transaminase assay should find its greatest use as an adjunct in the interpretation of an elevated oxalacetic transaminase level.

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