Arrhythmias during Intracardiac Catheterization

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This paper summarizes the incidence of various arrhythmias in an unselected series of cardiac catheterizations and presents evidence for their reflex origin in some instances. The hazards are discussed and comments made about prophylaxis and treatment.

The patient who undergoes cardiac catheterization may develop an arrhythmia. It would be useful to know who is most susceptible, how hazardous the arrhythmia may be and what can be done about it.

Cournand1 mentioned premature contractions and runs of ventricular tachycardia as the most important complication in the procedure. Two cases were quoted in which death may have been the result of ectopic rhythms. Dexter2 reported irregularities of the heart in 27 out of 42 cases; 14 had symptoms referable to the arrhythmia. Bloomfield3 noticed many ventricular premature systoles, while Levine4 described seven cases with disorder of the heart beat of auricular origin with the tip of the intracardiac electrode in the right auricle. He found that a high percentage of subjects developed arrhythmias when the tip was in the right ventricle. Most reports infer that the great majority of irregularities are of ventricular origin, induced when the catheter, especially its tip, is in the vicinity of the interventricular septum.

The present study details the type and incidence of disorders in the cardiac mechanism noted in a consecutive series of cardiac catheterizations performed during a one-year period. The influence of age, sex, diagnosis, pulse rate and blood pressure has been analyzed.

Methods and Materials

One hundred and thirty-three patients were subjected to cardiac catheterization. Sixty per cent were men. The ages ranged from 7 months to 75 years. The diagnostic grouping is detailed in table 1.

A general anesthetic was administered in five cases. Local procaine infiltration was used in the remainder following premedication with sodium phenobarbital in a dose of 3 mg. per kilogram. A standard cardiac catheter was introduced into the heart in most instances by way of the antecubital vein. A direct-writing electrocardiograph was observed continuously during the procedure. The location of the catheter tip was determined fluoroscopically. Its position was also checked by measurements of pressure and blood oxygen saturation. In some questionable cases, roentgenograms were taken.

In evaluating the results of these studies, variability in any factor has been expressed as the standard deviation. Significance of differences between mean values was determined by calculating the ratio of the difference between means to the standard error of the difference.

Results

Incidence of Arrhythmias in Relation to Location of Catheter Tip

Arrhythmias were noted in 37 per cent of all patients catheterized (table 2). The incidence of arrhythmias was 19 per cent with the catheter tip in the right atrium, 20 per cent in the right ventricle and 19 per cent in the pulmonary arterial tree. The arrhythmias associated with the presence of the tip in the right atrium included four instances of sinus bradycardia, three of premature auricular systoles, two of paroxysmal auricular tachycardia, twenty of premature ventricular systoles, five of paroxysmal ventricular tachycardia, and one intraventricular block. The presence of the catheter tip in the right ventricle coincided with twelve cases of premature ventricular systoles, six of paroxysmal ventricular tachycardia and one of bigeminal rhythm. With the tip in the pulmo-
monary arterial tree there occurred three instances of premature ventricular systoles, one of bigeminal rhythm, three of paroxysmal ventricular tachycardia and one of intraventricular block.

In many instances, the point of origin of ectopic impulses coincided with the position of the catheter tip at the time of origin. In others, the initiation of impulses appeared compatible with direct stimulation by some portion of the catheter proximal to the tip. In a considerable number of cases, however, intra-auricular locations of the catheter tip were associated with a variety of extra-auricular rhythms. It appeared difficult to explain the mechanism of impulse origin in these instances except on a basis of reflex excitation consequent upon stimulation of some portion of the endocardial or endothelial surface other than the point of impulse formation.

In support of the latter hypothesis, serious arrhythmias followed insertion of the catheter in three instances before the tip had been advanced into the superior vena cava. In one subject, a young man suffering from an old traumatic arteriovenous aneurysm, the arrhythmia took the form of paroxysmal auricular fibrillation (fig. 1). The second subject was a young woman with mild rheumatic mitral disease and a severe cardiac neurosis. Alternating runs of paroxysmal auricular and ventricular tachycardia developed before the catheter had been advanced past the axilla (fig. 2). The third subject was a cyanotic baby 7 months of age, in whom a series of varied arrhythmias was initiated immediately following introduction of the catheter into the venous tree (fig. 3). In two other instances, severe sinus bradycardia

\[ \text{Fig. 1.—Paroxysmal fibrillation following insertion of catheter into vein. (All sequences taken with Lead II.)} \]

\[ \text{Fig. 2.—Paroxysmal tachycardia following insertion of catheter into vein. (All sequences taken with Lead II.)} \]
Table 1.—Diagnostic Grouping of 133 Patients on Whom Venocardiac Catheterizations Were Performed

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Number in Subgroup</th>
<th>Number Who Developed Arrhythmias</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertensive cardiovascular disease</td>
<td>68</td>
<td>17</td>
</tr>
<tr>
<td>Congenital heart disease</td>
<td>23</td>
<td>13</td>
</tr>
<tr>
<td>Coronary heart disease</td>
<td>14</td>
<td>8</td>
</tr>
<tr>
<td>Toxemia of pregnancy</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Rheumatic heart disease</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Cor pulmonale</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Noncardiac diseases</td>
<td>15</td>
<td>7</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>133</strong></td>
<td><strong>49</strong></td>
</tr>
</tbody>
</table>

Table 2.—Incidence of Arrhythmias in 133 Cases of Venocardiac Catheterization

<table>
<thead>
<tr>
<th>Type of Arrhythmia</th>
<th>Number of Instances</th>
<th>Percentage Incidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Premature ventricular systoles</td>
<td>35</td>
<td>55</td>
</tr>
<tr>
<td>Paroxysmal ventricular tachycardia</td>
<td>14</td>
<td>22</td>
</tr>
<tr>
<td>Sinus bradycardia</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>Premature auricular systoles</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Paroxysmal auricular tachycardia</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Bigeminal rhythm</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Intraventricular block</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

Fig. 3.—Arrhythmias initiated by insertion of catheter into vein. (All sequences taken with Lead III.)

A (1) illustrates pre-insertion pattern. (2) was taken immediately following catheter insertion. The remainder of the tracings represent return to pre-insertion values when the catheter insertion was halted.

B The sequences follow a second attempt at movement of the catheter in the direction of the vena cava.

C–E were taken after the catheter had been removed from the vein.
with vasovagal syncope appeared to have been initiated by the withdrawal of the catheter after uneventful diagnostic studies (fig. 4).

**TABLE 3.—Incidence of Pre-existing Electrocardiographic Abnormalities in 133 Patients Subjected to Venocardiac Catheterization**

<table>
<thead>
<tr>
<th>Pattern*</th>
<th>Number in Group</th>
<th>Percent in Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>48</td>
<td>36</td>
</tr>
<tr>
<td>Borderline or abnormal</td>
<td>85</td>
<td>64</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type of Abnormality*</th>
<th>Number</th>
<th>Number Who Developed Subsequent Arrhythmias</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left heart strain</td>
<td>18</td>
<td>5</td>
</tr>
<tr>
<td>Low voltage</td>
<td>18</td>
<td>7</td>
</tr>
<tr>
<td>Premature ventricular systoles</td>
<td>11</td>
<td>9</td>
</tr>
<tr>
<td>Intraventricular block</td>
<td>11</td>
<td>3</td>
</tr>
<tr>
<td>Premature auricular systoles</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Right heart strain</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Auricular fibrillation</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Sinus arrhythmia</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Chronic coronary insufficiency</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

* Terminology in accordance with that proposed by Katz.*

These instances indicate that the procedure, rather than the presence of the catheter or the tip location, is the factor primarily responsible for the development of certain of the arrhythmias associated with catheterization.

**Incidence in Relation to Diagnostic Classification**

The incidence of arrhythmias was greatest in patients with congenital heart disease (table 1). The percentage occurrence in this class was approximately twice as high as that in the remainder of the group, a difference which proved significant (t = 3.10).

Significant correlations were not demonstrated for any other diagnostic classification.

Age, sex and pre-existing pulse rate and blood pressure levels bore no statistically significant relation to the incidence of arrhythmias. An
apparent correlation with age was due to the greater number of patients with congenital heart disease in the younger age group.

**Relation to Pre-catheterization Electrocardiograms**

Control electrocardiograms were taken on all subjects to determine the presence of pre-existing abnormalities (table 3). Only 27 per cent of those with normal patterns developed arrhythmias; in contrast, the incidence among patients with prior abnormalities was 44 per cent. This difference proved significant (t = 2.07). No one type of electrocardiographic abnormality was present with sufficient frequency to permit correlation with subsequent development of arrhythmias.

**Treatment of Arrhythmias**

In the vast majority of cases, arrhythmias ceased when the catheter was moved to a different location. In six subjects removal of the catheter was required. In four of these, the arrhythmias subsided at once. In the fifth case, a bundle branch block persisted for several hours, then disappeared (fig. 5). Extensive studies failed to demonstrate any associated symptoms or signs. The sixth subject was the cyanotic baby previously mentioned. This child subsequently proved to have been suffering from a complete transposition of the aorta and pulmonary arteries associated with a patent foramen ovale and a small, high ventricular septal defect. Induction of Pentothal anesthesia preparatory to catheterization was marked by transient arrest of voluntary breathing overcome after a period of artificial respiration. The arrhythmias which followed insertion of the catheter persisted after its withdrawal. A normal rhythm was never re-established and a second period of respiratory failure led to a fatal outcome two hours later.

One other child with congenital disease developed temporary respiratory arrest during induction of Pentothal anesthesia. The procedure was terminated. This subject and two others were catheterized subsequently under Avertin anesthesia with no untoward effects.

The one instance of paroxysmal auricular fibrillation was controlled by intravenous injection of quinidine lactate. Vasovagal syncope responded in every case to ephedrine. The prophylactic injection of 25 mg. of ephedrine prior to removal of the catheter eliminated the occurrence of this arrhythmia following the procedure.

**Summary**

Thirty-seven per cent of 133 patients developed arrhythmias during veno-cardiac catheterization. The incidence was significantly higher in patients with congenital heart disease and in patients with pre-existing electrocardiographic abnormalities. Significant relations were not established with age, sex, heart rate, or blood pressure.

All arrhythmias were transitory with one exception. In that instance, anesthetic depression of the respiratory center in combination with a catheter-induced arrhythmia appeared to have contributed directly to a fatal outcome. The experience with anesthetic agents indicates that one episode of respiratory arrest following Pentothal anesthesia in a cyanotic child is a clear-cut indication not to proceed with the cardiac catheterization.

A percentage of arrhythmias appeared inexplicable on the basis of direct stimulation of the site of impulse formation. The hypothesis is advanced that such arrhythmias may have resulted from reflex activity which excited normal or ectopic foci of impulse formation.

**REFERENCES**

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