Ventricular Aneurysm
A Reappraisal Based on a Study of Sixty-Five Consecutive Autopsied Cases

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The recognition of ventricular aneurysms is of practical importance now that surgical repair is advocated to deal with their complications. These complications consist primarily of intractable congestive heart failure, systemic emboli secondary to mural thrombi in the aneurysmal sac, and myocardial rupture. In this retrospective study the clinical course of patients with ventricular aneurysm was reviewed to evaluate the diagnostic criteria and to assess the possible role of surgical therapy.

Material and Methods
In 2,809 consecutive autopsies performed at the Michael Reese Hospital and Medical Center from 1956 through 1961, 65 patients with ventricular aneurysm were found. In each of these patients the clinical laboratory and autopsy records were reviewed.9

Results
Incidence
The incidence of ventricular aneurysms in the total autopsy series was 2.3 per cent (table 1). Ventricular aneurysms were present in 12.4 per cent of 508 patients with myocardial infarction noted at autopsy during the same period. They were 4 times more frequent in men than in women (table 2), whereas myocardial infarction (old or recent) showed only a 1.9 times greater incidence in men over women. One patient had two distinct aneurysms. Two of the aneurysms occurred in the absence of myocardial infarction: one was myocytic in a patient with subacute bacterial endocarditis; the other occurred in a patient who had hypertension secondary to chronic renal disease.

Survival
The average age at death of patients with ventricular aneurysms was 67.7 years, the greatest number of deaths occurring in the seventh and eighth decades (table 2). In 18 patients there was insufficient clinical data to determine the length of survival after infarction. In the remaining patients with ventricular aneurysms secondary to myocardial infarction, death occurred between 1 month and 20 years after the first myocardial infarction. The average survival from the onset of the first myocardial infarction was 7.2 years; 69 per cent survived 5 years or more.

Cause of Death
Acute myocardial infarction, occurring in 32 patients, was the most frequent cause of death. In seven patients death was due to intractable congestive heart failure.

Five of these seven patients had severe generalized coronary atherosclerosis at autopsy. In the sixth, heart failure was secondary to an unremitting supraventricular tachycardia. The degree of coronary atherosclerosis could not be determined from the data in the seventh patient of this group.

Rupture of the aneurysm was responsible for three deaths occurring in the patient with a myocytic aneurysm and in two patients after acute myocardial infarction in the area of infarction. No deaths were due to systemic
emboli. Twenty-three patients died of causes unrelated to the heart (e.g., bronchopneumonia, malignancy, uremia, etc.).

Location and Size

The location of the ventricular aneurysm relative to the site of the myocardial infarction in the 65 patients is shown in table 3. The anatomic location of the aneurysms is shown in table 4.

The aneurysm size was not measured routinely. In the 18 patients in whom such measurements were recorded the diameter varied from 1 to 8 cm., with an average diameter of 4 cm.

Systemic Embolic Phenomena

Mural thrombi were present in the aneurysmal sacs of nine patients, four of whom had evidence of systemic embolic phenomena at postmortem examination. Five other patients had evidence of peripheral emboli without mural thrombi present in the aneurysm at autopsy. Forty-five patients had no mural thrombi and no evidence of systemic embolic phenomena. Many of the patients in this series received anticoagulants at some time during their lifetime, but the available data did not permit detailed evaluation.

Clinical Findings

There were no consistent characteristic physical, radiologic, or electrocardiographic findings of ventricular aneurysm in this series. Many patients had evidence of old or recent myocardial infarction in the electrocardiogram. Thirty-three of 55 patients (60 per cent) had cardiomegaly on chest x-ray, some of these suggesting disproportionate left ventricular enlargement.

The diagnosis was made ante mortem in four of the 65 patients (6 per cent). In one the diagnosis was based on the finding of a calcified aneurysmal sac in the chest x-ray. The diagnosis in a second patient was based on electrocardiographic changes. The basis for the diagnosis was not apparent in the remaining two patients.

Twenty-four patients had diabetes mellitus. Fourteen patients had a diastolic systemic arterial blood pressure over 90 mm. Hg on their final hospital admission. There was insufficient information concerning the length of the period of bed rest after myocardial infarction to permit analysis of this factor.

Prior to death 39 patients had one clinically known old myocardial infarction, 14 patients had two known previous infarctions, and two patients had three known old infarctions. There was no clinical evidence of previous myocardial infarction in six patients, includ-

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**Table 1**

Incidence of Myocardial Infarction and Ventricular Aneurysm in 2,809 Consecutive Autopsies (1956-1961)

<table>
<thead>
<tr>
<th>Condition</th>
<th>Number of Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Myocardial infarction (with and without aneurysm)</td>
<td>508</td>
</tr>
<tr>
<td>Ventricular aneurysm (total)</td>
<td>65</td>
</tr>
<tr>
<td>Ventricular aneurysm associated with myocardial infarction</td>
<td>63</td>
</tr>
</tbody>
</table>

**Table 2**

Age at Death and Sex of Patients with Ventricular Aneurysm

<table>
<thead>
<tr>
<th>Age at death, years</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>40-49</td>
<td>5</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>50-59</td>
<td>12</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>60-69</td>
<td>13</td>
<td>3</td>
<td>16</td>
</tr>
<tr>
<td>70-79</td>
<td>19</td>
<td>5</td>
<td>24</td>
</tr>
<tr>
<td>80-89</td>
<td>3</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>90-99</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>52</td>
<td>13</td>
<td>65</td>
</tr>
</tbody>
</table>

Average age at death in years: 65.2 (67.7)

**Table 3**

Location of Ventricular Aneurysm Relative to the Site of Myocardial Infarction in 65 Patients

<table>
<thead>
<tr>
<th>Description</th>
<th>Number of Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>At site of old myocardial infarction</td>
<td>39</td>
</tr>
<tr>
<td>At site of recent myocardial infarction</td>
<td>6</td>
</tr>
<tr>
<td>At site of old and recent myocardial infarctions (in the same area)</td>
<td>15</td>
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<tr>
<td>No myocardial infarction</td>
<td>2</td>
</tr>
<tr>
<td>Not determined from available data</td>
<td>3</td>
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</table>
Table 4

Anatomic Location of Ventricular Aneurysm in 65 Patients

<table>
<thead>
<tr>
<th>Apex</th>
<th>Anterior wall</th>
<th>Interventricular septum</th>
<th>Posterior wall</th>
<th>Lateral wall</th>
<th>Right ventricle</th>
<th>Number of aneurysms</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>20</td>
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<tr>
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<td></td>
<td>X</td>
<td></td>
<td></td>
<td>2</td>
</tr>
</tbody>
</table>

Location in left ventricle not specified

One patient had two distinct aneurysms.

The apex and posterior wall of the heart were the most common sites of the aneurysms. The difficulties in the x-ray diagnosis of aneurysms in these areas with conventional posteroanterior and lateral chest views are well known. Calcification of the aneurysmal sac in the chest x-ray was rare, and made the clinical diagnosis possible in only one patient. Cardiomegaly was frequent on x-ray, being present in 60 per cent of 55 patients. These x-rays, however, were usually taken shortly after reinfarction or prior to the death of the patient and did not serve as an indication for further investigation, even though “disproportionate left ventricular enlargement” was at times suggested by the radiologists.

The major electrocardiographic finding was that of old or recent myocardial infarction. Intraventricular conduction disturbances, probably secondary to the infarction, were frequent. On occasion atrial fibrillation was seen. The “sine qua non” of ST-segment elevation was rare, being present in only one patient. As has been previously stated, there appeared to be no single characteristic electrocardiographic pattern of ventricular aneurysm.

Thus, clinical, radiologic, and electrocardiographic findings that might lead to a valid consideration of the diagnosis of aneurysm.
ventricular aneurysm

of the ventricle were usually lacking. This may help explain why this lesion is considered so infrequently clinically. The data suggest, however, that a ventricular aneurysm should be particularly considered in diabetic patients, especially men, with cardiomegaly and a history of myocardial infarction.

The frequency of diagnosis might be increased if chest x-rays were routinely taken at intervals starting several months after infarction has occurred. Although electrocardiography has proved unrewarding,\(^{14}\) roentgenkymography may be of value in patients in whom there is a suspicion of aneurysm. Furthermore, selective left ventricular angiocardiography should be considered when the diagnosis is suspected and cannot be confirmed by simpler laboratory procedures.

It is quite apparent that the criteria for the diagnosis of ventricular aneurysm are generally inadequate. This defect in our diagnostic ability may not be too serious in view of the relatively favorable prognosis of patients with ventricular aneurysm noted in this series.

The vast number of deaths were not due to the known complications of ventricular aneurysm. About 50 per cent of patients died from an acute myocardial infarction, and another 35 per cent died of causes unrelated to the heart. In only 13.8 per cent of the patients could death be considered to be a complication of the aneurysm. An analysis of this latter group reveals that five of the six patients who died of chronic progressive heart failure had severe generalized coronary atherosclerosis at autopsy. In such patients it cannot be assumed that the aneurysm is markedly affecting the hemodynamic integrity of the left ventricle. The inadequacy of the ventricle may be primarily caused by impairment of muscle function due to diminished coronary circulation to the intact myocardium. No patient died of systemic embolic phenomena, though evidence of systemic embolization was found at autopsy in nine patients. The difference between this and other series regarding the frequency of emboli may be due to the increased use of anticoagulants recently.

Mural thrombi were present in the aneurysmal sacs of only four patients. Death due to rupture of an aneurysm secondary to recent myocardial infarction occurred in only two patients.

Contrary to several previously reported series\(^{10,11}\) ventricular aneurysm in the present study was not associated with a markedly limited survival. Patients died at an average age of 67.7 years, and survived an average of 7.2 years after their first myocardial infarction. Moreover, the 5-year survival following the first myocardial infarction was 69 per cent in 45 patients in whom this could be determined.

Thus, the prognosis compares favorably with the long-term survival following myocardial infarction in 285 patients studied at this institution by Cole, Singian, and Katz.\(^{15}\) The 5-year survival rate in their series was 66.6 per cent; the average length of survival after the first infarction was 8.2 years, and the average age at death was 64.9 years. In reviewing eight studies of survival following first myocardial infarctions, McMichael and Parry\(^{16}\) found an average 5-year survival of 65.7 per cent. Although the manner of assembling cases in the present series and the previous ones with which it is compared is somewhat different, the data nevertheless suggest that the presence of a ventricular aneurysm secondary to myocardial infarction does not affect the statistical prognosis.

It is apparent that the hemodynamic significance of a ventricular aneurysm depends on a number of factors. The larger the size of the aneurysm, the greater is the burden it places upon the left ventricle. It has been suggested that an aneurysm, filling at the time of ventricular systole, functions in a manner similar to that of mitral regurgitation. The emptying of the aneurysmal sac during diastole, with the resultant addition of this blood to that coming from the left atrium, is considered to have the same hemodynamic effect as aortic insufficiency.\(^{17}\) Moreover, it is obvious that the dynamic state of the heart independent of the aneurysm is also an important consideration.
Several circumstances affect the expansibility of the aneurysm aside from its size. Pericardial adhesions forming at the aneurysmal site may serve to lessen the systolic expansion of the weakened area by increasing its rigidity. An adherent organized endocardial thrombus may also operate to decrease the size of the aneurysmal sac and augment rigidity. Calcium deposition into the wall of the aneurysm may be associated with marked fibrosis, which will decrease the expansibility of the aneurysm. In a series of patients previously reported,18 calcified ventricular aneurysms were associated with relative longevity. Indeed, one patient is reported19 to have survived 28 years after the original myocardial infarction. The one patient with a calcified aneurysm in the present series lived 11 years subsequent to his first myocardial infarction and eventually died of a lymphosarcoma.

Surgery for ventricular aneurysm is connected with a substantial surgical risk. Review of the 28 operated cases of ventricular aneurysm following myocardial infarction reported up to 1962 in the English literature17, 20-26 revealed nine surgical deaths, or a surgical mortality of 32 per cent. In 1962 a series of 60 operated cases was reported from the U.S.S.R. with the remarkably small mortality of only two surgical deaths.27 Nevertheless, when these reported results are combined, the over-all surgical mortality is 11 per cent. The longest survival after surgery reported thus far is 26 months.23

Our data urges caution in the utilization of surgery for myocardial aneurysms. The infrequent occurrence of rupture of the aneurysm essentially removes this complication as an indication for surgery. This is particularly true, since it is generally undesirable to operate upon patients soon after a recent myocardial infarction—the time when rupture occurs. The presence of chronic congestive heart failure was associated with marked generalized coronary atherosclerosis, which in itself is a contraindication to this type of surgery. It appears that coronary arteriography, to assess the competence of the coronary circulation, and left ventricular angiography, to assess the cyclic expansion of the aneurysm, will often be indicated to help make a reasonable decision concerning the need for surgery.

In view of the foregoing considerations it would seem wise to take a conservative approach to surgery for aneurysms of the ventricle. It is suggested that surgery be restricted to (a) patients with evidence that the ventricular aneurysm is expansile, (b) patients with a ventricular aneurysm and progressive heart failure refractory to medical therapy in whom coronary arteriography reveals an adequate coronary circulation to the remainder of the ventricle, and (c) patients with ventricular aneurysm in whom repeated systemic emboli cannot be controlled with anticoagulant therapy. Surgery, when indicated for aneurysms secondary to myocardial infarction, ideally should be performed at least 3 months after the infarction has occurred.

Summary

Sixty-five consecutive autopsied cases of ventricular aneurysm are reviewed. The incidence of aneurysm following myocardial infarction is similar to that reported in other series. Myocardial infarction preceded the formation of an aneurysm of the ventricle in the vast majority of patients, and a new myocardial infarction was the cause of death of about 50 per cent of them. The survival rate of patients with ventricular aneurysm is not significantly different from the long-term survival of all patients with myocardial infarction found in the same institution. Complications of ventricular aneurysm such as chronic congestive heart failure and rupture of the aneurysm were infrequent causes of death, and systemic embolic phenomena were not observed as a cause of death. In only four patients was the diagnosis made ante mortem. The lack of characteristic clinical, radiologic, and electrocardiographic findings is discussed. It is suggested that the hemodynamic significance of ventricular aneurysms is not ordinarily great, in view of the unaffected statistical prognosis in its presence. The recommended indications for surgery of ventricular aneu-

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References


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