Elective operations for left ventricular asynergy

FRANK GERBODE, WILLIAM J. KERTH, J. DONALD HILL, SACHINANDAN BANERJEE, and CARLO MARCELLETTI

Department of Cardiovascular Surgery, Presbyterian Hospital, and Heart Research Institute of the Institutes of Medical Science, Pacific Medical Center, San Francisco, California 94115, USA

Gerbode, F., Kerth, W. J., Hill, J. D., Banerjee, S., and Marcelletti, C. (1974). Thorax, 29, 282-286. Elective operations for left ventricular asynergy. Operative results in 45 patients with symptomatic left ventricular asynergy are reviewed. The main symptoms were congestive heart failure in 77.7%, angina in 31.1%, arrhythmias in 11.1%, and systemic thromboembolism in 2.2% of the patients.

All patients had left heart catheterization, 40 had left ventricular angiography, and 27 had selective coronary arteriography. The last myocardial infarction occurred within three months preoperatively in 15 patients and more than 13 months prior to surgery in 27 patients.

The cardiac index was 1.5 l/m²/min or less in six patients and the left ventricular end diastolic (LVED) pressure was 25 mmHg or higher in 15 patients.

All patients were operated upon electively with the use of cardiopulmonary bypass. Excision of the left ventricular aneurysm was performed in 39 cases and plication in six.

The immediate survival rate was 66.6%. The lowest mortality rate was among patients with angina (12.5%) and the highest in those with association of congestive heart failure and angina (66.6%).

The mortality rates among patients with recent or old myocardial infarction were 46.6 and 22.2% respectively.

One of the six patients with a cardiac index of 1.5 l/m²/min or less and seven of the 15 patients with LVED pressure of 25 mmHg or higher were discharged from hospital.

It is concluded that ventricular aneurysmectomy has to be considered an elective procedure in order to obtain predictable results and that ideal indications for operation are angina or congestive heart failure refractory to medical treatment, associated with acceptable haemodynamics, a cardiac index of 2.0 l/m²/min or higher, and a LVED pressure below 25 mmHg.

Beck (1944) was the first to describe a planned operation for a ventricular aneurysm by external reinforcement with pericardium and fascia lata. Likoff and Bailey (1955) reported the use of clamps for a left ventricular aneurysmectomy by a closed heart technique, and Cooley, Collins, Morris, and Chapman (1958) reported the first open excision using cardiopulmonary bypass. Since then, a number of reports have been published on left ventricular aneurysmectomy with the use of cardiopulmonary bypass (Cooley and Hallman, 1968; Favaloro et al., 1968; Key, Aldridge, and MacGregor, 1968; Lindesmith et al., 1970; Kay et al., 1970; Schattenberg, Giuliani, Campion, and Danielson, 1970; Tice, Cheng, and Dolgin, 1970; Kluge et al., 1971; Loop, 1971; Graber et al., 1972; Stoney, Alford, Burrus, and Thomas, 1973).

Between 1960 and December 1972 at the Pacific Medical Center in San Francisco, a total of 75 left ventricular aneurysmectomies were performed in patients with cineangiographic evidence of abnormal motion of the left ventricle, according to Gorlin's functional definition (Gorlin, Klein, and Sullivan, 1967), associated with clinical cardiac symptoms either chronic or acute. The overall operative results have been reported elsewhere (Gerbode et al., 1974).
This report analyses the indications for surgical treatment and the results in a group of 45 patients who were electively operated upon and had preoperative haemodynamic evaluation by means of left heart catheterization.

MATERIAL AND METHOD
Of the 45 patients, 38 were male and seven female, a ratio of 5.4:1. Their ages ranged between 30 and 74 (mean 58) years.

The main symptoms were those of congestive heart failure in 35 (77.7%) patients, angina in 14 (31.1%), arrhythmias in five (11.1%), and systemic thromboembolism in one (2.2%).

The indications for operation included intractable congestive heart failure in 26 patients, angina in eight, life-threatening arrhythmias in two, association of congestive heart failure with angina in six, and congestive heart failure with arrhythmias in three patients.

Apart from the routine examination, all 45 patients had left heart catheterization, 40 had left ventricular angiography, 26 had selective coronary angiography, and 27 had complete haemodynamic and angiographic studies.

Of a total of 42 patients with documented electrocardiographic evidence of either single or multiple myocardial infarctions, 15 had their last myocardial infarction within three months of operation and 27 more than three months prior to operation.

According to the selective coronary angiographic studies, 14 patients had three vessel disease, 10 had two vessel disease and two patients had single vessel disease.

All patients were operated upon using cardiopulmonary bypass with normothermia or moderate hypothermia and intermittent aortic cross-clamping. Excision of left ventricular aneurysm was performed in 39 patients and a plication technique was used in six cases. Mural thrombosis was found in 13 patients.

The aneurysmectomy was combined with mitral and/or aortic commissurotomy and/or valve replacement in four cases, closure of postmyocardial infarction ventricular septal defect in one, and single or multiple aorta to coronary artery saphenous vein bypass grafts in 16 patients.

RESULTS
Thirty patients were discharged from hospital, an immediate survival rate of 66.6%.

A correlation between the main symptoms and the hospital deaths is shown in Table I. The angina group appeared to have the lowest hospital death rate (12.5%). The three patients with symptoms of congestive heart failure associated with arrhythmias were all discharged from hospital after operation.

<table>
<thead>
<tr>
<th>Table I</th>
<th>MAIN PREOPERATIVE SYMPTOMS IN 45 PATIENTS WITH LEFT VENTRICULAR ASYNERGY TREATED SURGICALLY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Symptoms</td>
<td>No. of Patients</td>
</tr>
<tr>
<td>CHF</td>
<td>26</td>
</tr>
<tr>
<td>Angina</td>
<td>8</td>
</tr>
<tr>
<td>Arrhythmias</td>
<td>2</td>
</tr>
<tr>
<td>CHF and angina</td>
<td>6</td>
</tr>
<tr>
<td>CHF and arrhythmias</td>
<td>3</td>
</tr>
</tbody>
</table>

CHF = congestive heart failure.

Table II refers to the time of the procedure in relation to the last documented myocardial infarction and relative hospital mortality rates. The hospital deaths were seven (46.6%) among the 15 patients who had their last myocardial infarction less than three months before operation and six (22.2%) among the 27 patients in whom the operation was performed later than three months after the last documented myocardial infarction.

<table>
<thead>
<tr>
<th>Table II</th>
<th>TIME OF OCCURRENCE OF LAST MYOCARDIAL INFARCTION PRIOR TO SURGICAL TREATMENT IN 45 PATIENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Last Myocardial Infarction prior to Surgery</td>
<td>No. of Patients</td>
</tr>
<tr>
<td>Less than three months</td>
<td>15</td>
</tr>
<tr>
<td>More than three months</td>
<td>27</td>
</tr>
</tbody>
</table>

Table III shows the preoperative haemodynamic status of the patients grouped according to their main symptoms.

<table>
<thead>
<tr>
<th>Table III</th>
<th>PREOPERATIVE HAEMODYNAMIC DATA IN 45 PATIENTS WITH LEFT VENTRICULAR ASYNERGY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Symptoms</td>
<td>No. of Patients</td>
</tr>
<tr>
<td>CHF</td>
<td>26</td>
</tr>
<tr>
<td>Angina</td>
<td>8</td>
</tr>
<tr>
<td>Arrhythmia</td>
<td>2</td>
</tr>
<tr>
<td>CHF and angina</td>
<td>6</td>
</tr>
<tr>
<td>CHF and arrhythmia</td>
<td>3</td>
</tr>
</tbody>
</table>

CHF = congestive heart failure.
CI = cardiac index (at rest).
LVEDP = left ventricular end diastolic pressure (at rest).

DISCUSSION
Experimental and clinical attempts to outline the pathophysiological implications of left ventricular asyn-
ergy have shown that when an area of akinesia approaches 20–25% of the left ventricular surface area, the extent of fibre shortening required of the functioning myocardium begins to exceed physiological limits (Austen et al., 1962; Herman, Heine, Klein, and Gorlin, 1967; Klein, Herman, and Gorlin, 1967; Herman and Gorlin, 1969). The coronary circulation, handicapped by atherosclerosis, may not be able to deliver the additional oxygen required (Ellis, 1971). The clinical verification of the above observation is the fact that congestive heart failure and angina are the most common symptoms of left ventricular asynergy (Davis and Ebert, 1972). In our series these symptoms were present in 77.7% and 31.1%, respectively.

Experimental studies have recently claimed that removal of over 30–35% of the canine left ventricular myocardium does not permit survival (Stein and Cordell, 1969). Therefore, the surgical treatment of symptomatic left ventricular asynergy in patients where the area of resectable muscle is within a narrow range is a complicated matter.

As stated in the introduction, we have accepted the functional definition of left ventricular aneurysm, and the consequent selection of candidates for operation makes our report not comparable with those of other authors (Cooley et al., 1958; Favaloro et al., 1968; Kay et al., 1970; Schattenberg et al., 1970; Loop, 1971; Graber et al., 1972; Stoney et al., 1973) who have used Edwards' (1961) definition of left ventricular aneurysm as 'a protrusion of a localized portion of the external aspect of the left ventricle beyond the remainder of the cardiac surface with simultaneous protrusion of the cavity as well'. This definition selects a population of patients with a clear anatomical lesion and may account for better surgical results.

Our hospital mortality rates are closer to those reported by Kay et al. (1970—32%) and by Lindesmith et al. (1970—26%). Both these authors have selected their patients on the basis of symptomatic left ventricular asynergic areas. Our hospital mortality of 30%, decreased to 22-2% in patients who had the operation more than three months after their last myocardial infarction, as suggested by Lindesmith et al. (1970).

A certain time interval is needed for the necrotic wall of the left ventricle to be converted into fibrous tissue in order to hold sutures securely. But even more important is the fact that the operation should be deferred until time has allowed the left ventricle to adapt itself to the new haemodynamic situation of an asynergic area and the increased mechanical load required by the remaining functional myocardium.

Other significant considerations arise when the preoperative haemodynamic status is taken into account. The cardiac index was found to be 1.5 l/m2/min or less in six of our patients and only one of them was discharged from hospital. A LVED pressure of 25 mmHg or higher was found in a group of 15 patients of whom only seven left hospital.

The best surgical results were obtained in patients whose main symptoms were angina or congestive heart failure associated with arrhythmias. These two groups of patients were characterized by the best preoperative haemodynamic status with a mean cardiac index above 2.0 l/m2/min and a mean LVED pressure below 25 mmHg. In the congestive heart failure group, the difference of mean cardiac index and LVED pressure between survivors and deaths was 2:2 versus 1:7 l/m2/min and 23:4 versus 28:5 mmHg.

We feel that only a very accurate preoperative or intraoperative quantification of the amount of resectable left ventricle could give absolute indication or contraindication for aneurysmectomy. This stage of accuracy has not yet been reached in the treatment of postinfarction left ventricular asynergy.

A critical clinical evaluation of symptoms associated with measurements of cardiac index and LVED pressure can still provide useful criteria for surgical treatment.

CONCLUSION

From the review of our experience in the surgical management of symptomatic left ventricular asynergy the following conclusions could be drawn:

(a) Wide clinical differences in the population of candidates for left ventricular aneurysmectomy and the use of the anatomical or functional definition of left ventricular aneurysms are probably responsible for the conflicting results reported by various authors (Table IV).

(b) The operation of ventricular aneurysmectomy has to be considered essentially an elective procedure in order to obtain predictable results.

(c) Ideal indications for operation are angina and congestive heart failure refractory to medical treatment, associated with acceptable haemodynamics, that is, a cardiac index of 2.0 l/m2/min or more and a LVED pressure below 25 mmHg.
Elective operations for left ventricular asynergy

### TABLE IV

<table>
<thead>
<tr>
<th>Reference</th>
<th>No. of Patients</th>
<th>Hospital Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
</tr>
<tr>
<td><strong>Anatomical definition</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Favaloro et al. (1968)</td>
<td>130</td>
<td>17</td>
</tr>
<tr>
<td>Cooley et al. (1968)</td>
<td>80</td>
<td>16</td>
</tr>
<tr>
<td>Graber et al. (1972)</td>
<td>23</td>
<td>5</td>
</tr>
<tr>
<td>Stoney et al. (1973)</td>
<td>29</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>262</td>
<td>41</td>
</tr>
<tr>
<td><strong>Functional definition</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lindesmith et al. (1970)</td>
<td>38</td>
<td>10</td>
</tr>
<tr>
<td>Kay et al. (1970)</td>
<td>31</td>
<td>10</td>
</tr>
<tr>
<td>Tice et al. (1970)</td>
<td>14</td>
<td>0</td>
</tr>
<tr>
<td>PMC (1973)</td>
<td>45</td>
<td>15</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>128</td>
<td>35</td>
</tr>
</tbody>
</table>

**PMC = Pacific Medical Center present series.**

(e) The haemodynamic parameters are most valuable in screening the candidates for operation, and figures of cardiac index of 1.5 l/m²/min or less and LVED pressure of over 25 mmHg contra-indicate excision of areas of left ventricular asynergy.

Despite several uncertainties, mainly concerning a method for accurate anatomical definition of the site and amount of asynergic areas, operations for asynergy of the left ventricle have an important role in the management of a well selected group of patients in whom symptoms are not relieved by medical treatment.

As with most of the surgical approaches to acquired heart disease, ventricular aneurysmectomy is essentially a palliation complementary to medical therapy.

REFERENCES


F. Gerbode, W. J. Kerth, J. D. Hill, S. Banerjee, and C. Marcelletti


Requests for reprints to: Dr. F. Gerbode, The Heart Research Institute of the Institutes of Medical Science, Pacific Medical Center, San Francisco, California, 94115. U.S.A.
Elective operations for left ventricular asynergy

Frank Gerbode, William J. Kerth, J. Donald Hill, Sachinandan Banerjee and Carlo Marcelletti

Thorax 1974 29: 282-286
doi: 10.1136/thx.29.3.282

Updated information and services can be found at:
http://thorax.bmj.com/content/29/3/282

These include:

Email alerting service
Receive free email alerts when new articles cite this article. Sign up in the box at the top right corner of the online article.

Notes

To request permissions go to:
http://group.bmj.com/group/rights-licensing/permissions

To order reprints go to:
http://journals.bmj.com/cgi/reprintform

To subscribe to BMJ go to:
http://group.bmj.com/subscribe/