Pump Failure in Myocardial Infarction

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The hospital mortality for myocardial infarction is decreased by the aggressive management of electrical failure. Pump (power) failure of the heart and its extreme manifestation, cardiogenic shock, remains the single most important cause of hospital mortality in acute myocardial infarction. To find a clue to the treatment, pathophysiology of myocardial infarction with pump failure was studied.

I. Pump failure immediately after the initial attack

Materials and Methods
During recent ten years (1961–1970) 30 patients with acute myocardial infarction died of pump failure in Keio University Hospital. Among them 13 patients died within two weeks after the initial attack of myocardial infarction. Clinical course and autopsy findings of the 13 patients were studied.

Results and Discussion
The 13 patients were shown in Table 1.

<table>
<thead>
<tr>
<th>Case</th>
<th>Duration (days)</th>
<th>Localization</th>
<th>Pulmonary congestion</th>
<th>Heart rate (/min)</th>
<th>Systemic arterial pressure (mmHg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>64 yrs</td>
<td>A, L</td>
<td>—</td>
<td>100</td>
<td>60 Rup.</td>
</tr>
<tr>
<td>2</td>
<td>61 yrs</td>
<td>A, L</td>
<td>—</td>
<td>100</td>
<td>80 Rup.</td>
</tr>
<tr>
<td>3</td>
<td>66 yrs</td>
<td>A, L</td>
<td>+</td>
<td>100</td>
<td>90/70</td>
</tr>
<tr>
<td>4</td>
<td>83 yrs</td>
<td>A</td>
<td>+</td>
<td>80</td>
<td>60</td>
</tr>
<tr>
<td>5</td>
<td>80 yrs</td>
<td>I</td>
<td>+</td>
<td>80</td>
<td>60</td>
</tr>
<tr>
<td>6</td>
<td>64 yrs</td>
<td>A</td>
<td>+</td>
<td>100</td>
<td>60</td>
</tr>
<tr>
<td>7</td>
<td>47 yrs</td>
<td>A</td>
<td>+</td>
<td>112</td>
<td>100/60 MR</td>
</tr>
<tr>
<td>8</td>
<td>69 yrs</td>
<td>A, L</td>
<td>+</td>
<td>120</td>
<td>96/80 MR</td>
</tr>
<tr>
<td>9</td>
<td>70 yrs</td>
<td>I</td>
<td>++</td>
<td>90</td>
<td>160/80 MR</td>
</tr>
<tr>
<td>10</td>
<td>77 yrs</td>
<td>A</td>
<td>+</td>
<td>120</td>
<td>124/76 MR</td>
</tr>
<tr>
<td>11</td>
<td>67 yrs</td>
<td>I</td>
<td>+</td>
<td>90</td>
<td>60</td>
</tr>
<tr>
<td>12</td>
<td>61 yrs</td>
<td>I</td>
<td>++</td>
<td>100</td>
<td>80/60</td>
</tr>
<tr>
<td>13</td>
<td>72 yrs</td>
<td>A, L</td>
<td>++</td>
<td>100</td>
<td>86/44</td>
</tr>
</tbody>
</table>

Duration: duration from the initial attack to death  
A: anterior wall  I: inferior wall  
Rup.: rupture  MR: mitral regurgitation

Key Words: Cardiogenic Shock  
Pump Failure  
Power Failure

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Case 1 and 2 were suffered from antero-lateral infarction. In both cases suddenly cardiac rupture occurred and cardiogenic shock developed rapidly. Both patients died within 24 hours after the initial attack. Autopsy revealed rupture of the anterior wall. Cardiomegaly and pulmonary congestion were absent.

Case 3,4,5,6,11 showed hypotension immediately after the attack and they were accompanied by rapidly developing shock. Except case 11 they died within two days. Case 11 was getting better since 2nd day, but on the 9th day again she was accompanied by rapidly developing shock and died. These five cases showed radiological pulmonary congestion without significant cardiomegaly. Autopsy revealed recent complete or subtotal occlusion of the left coronary artery.

Case 7 and 8 showed mitral regurgitation due to papillary muscle dysfunction. These two cases showed marked pulmonary congestion and cardiomegaly.

Case 9, 10, 12, 13 showed gradual increase in cardiomegaly and pulmonary congestion and died.

The study revealed that pump failure immediately after the initial attack of myocardial infarction was not a homogeneous entity, but was divided into several groups according to the pathophysiology.

Group 1: Pump failure due to cardiac rupture. The patient was accompanied by rapidly developing shock and died without cardiomegaly or pulmonary congestion. Only treatment for patients in Group 1 is an emergent surgery.

Group 2: Pump failure due to papillary muscle dysfunction. Patients in Group 2 revealed progressing left heart failure with marked cardiomegaly and pulmonary congestion. For patients in Group 2 mitral valve replacement is emphasized.

Group 3: Pump failure due to acute coronary occlusion. Patients in Group 3 were all accompanied by rapidly developing Shock immediately after the initial attack and died within.

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two days. Radiological pulmonary congestion without cardiomegaly was seen. Autopsy revealed recent complete or subtotal coronary occlusion. Sudden loss of contractility was supposed the primary cause. Although treatment should be variable according to the cardiac output and peripheral resistance, aorto-coronary bypass surgery (saphenous vein bypass graft surgery) would be most effective. To prevent production of MDF (myocardial depressant factor) steroid hormone (methylprednisolone 30mg/kg intravenously) or α blockade (phenytoin, phentolamine) is employed. Group 4: Pump failure due to classical left heart failure. Patients in Group 4 showed marked cardiomegaly and signs of pulmonary edema. They are characterized by the end stage of acute left heart failure. To manage these patients digitalis, glucagon and dopamine are employed.

II. Pump failure over two weeks after the initial attack

RESULTS AND DISCUSSION

51 patients with myocardial infarction, from 30 to 72 years old, were studied. The catheterization was performed at least two weeks after the initial attack of myocardial infarction. Coronary sinus, right heart and transeptal left heart catheterization were performed. Left heart failure was diagnosed by an elevated mean left atrial pressure.

MATERIALS AND METHODS

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Panel Discussion on Treatment of Congestive Heart Failure

Fig. 5. Symbols same as Fig. 1.

Fig. 6. Symbols same as Fig. 1.

Fig. 7. Symbols same as Fig. 1.

Fig. 8. Symbols same as Fig. 1.

Fig. 9. Symbols same as Fig. 1.

Japanese Circulation Journal Vol. 37, April 1973
than that in Group I (P < 0.001) (Fig. 3).
Cardio-thoracic ratio (CTR) in Group II was significantly greater than that in Group I (P < 0.005) (Fig. 4).

Enddiastolic volume of the left ventricle (EDV) was not significantly different between Group I and Group II (P > 0.1) (Fig. 5).

Fig. 6 shows the relationship between enddiastolic volume of the left ventricle (EDV) and mean left atrial pressure (PLA). When EDV increased, PLA increased. But some cases with normal EDV showed elevated PLA, and two cases with increased EDV showed marked PLA elevation. Such results were suggestive of abnormal left ventricular compliance in myocardial infarction and also suggestive of asynchrony of left ventricle. This was the reason why EDV was not significantly different between Group I and II.

Fig. 7 shows the relationship between stroke volume index (SVI) and mean left atrial pressure (PLA) in cases of coronary artery disease (myocardial infarction was excluded). When PLA increased, SI increased. But such cases with markedly elevated PLA showed decreased SI.

Fig. 8 shows the same relationship between SI and PLA in cases of myocardial infarction. Compared with other coronary artery disease cases some cases with decreased SI were seen. Especially some cases with slightly increased PLA showed marked decrease in SI. Such results suggested asynchrony of the left ventricle in myocardial infarction.

These results suggested that left ventricular asynchrony and abnormal left ventricular compliance took part in pump failure in myocardial infarction. Therefore, when intractable left heart failure persist despite of medical therapy, surgical infarctectomy is indicated.

Fig. 9 shows the relationship between heart rate (HR) and stroke volume index (SVI) in myocardial infarction. Negative correlation was found between HR and SI (r = -0.71). Therefore in cases of myocardial infarction decrease in stroke volume index was compensated with increase in heart rate. Maroko et al. reported that administration of β-blockade (propranolol) within three hours after the coronary occlusion decreased extent and severity of myocardial ischemic injury and myocardial necrosis. But our data showed that in cases of myocardial infarction which elapsed more than two weeks after the initial attack propranolol would do no good by reducing heart rate.

**Summary**

To find a clue to the treatment, pathophysiology of myocardial infarction with pump failure was studied.

Pump failure was divided into two subsets, pump failure immediately after the initial attack and pump failure over two weeks after the initial attack.

In each subset, characteristics of pump failure in myocardial infarction were discussed.

**REFERENCES**