Stenotic Lesions and Length of the Left Main Coronary Artery in the Aged

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SUMMARY

To evaluate lesions of the left main coronary artery (LM) in the aged, a pathologic study was performed on a total of 972 consecutive autopsy cases over 60 years of age. The study population consisted of 503 men and 469 women with an average age at death of 79.0 years. In this study the degree of narrowing and length of the LM were evaluated in all cases (T), and the 141 cases with normal hearts (N) were compared with the 202 cases with myocardial infarction (MI).

The following results were obtained: (1) the average coronary stenotic index (CSI) was 9.1/15 in T, 5.8/15 in N and 11.2/15 in MI (N<MI, p<0.001), (2) the grade of narrowing in the LM (LMG), when 100% obstruction of the LM is counted as 5, was 1.8±0.9 in T, 1.3±0.6 in N and 2.3±1.1 in MI (N<MI, p<0.001). Cases showing more than 75% narrowing of the LM were found in 58 (6%), of which 35 cases belonged to MI, but development of MI directly due to lesions in the LM was found in only 9 patients (4.5% among MI), (3) the average length of the LM (LML) was 9.4±4.4 mm in T, 9.0±4.2 mm in N and 9.3±3.8 mm in MI (N vs MI; n.s.). Cases presenting left coronary artery dominance (n=82) or a balanced type (n=159) showed shorter LML than those with right coronary artery dominance (n=729) (8.5±4.0 mm, 8.8±4.6 mm and 9.7±4.4 mm, respectively, p<0.05), (4) in T there was a correlation between the LMG and CSI, but not between the LML and CSI. In conclusion, lesions of the LM in the aged were generally mild and the LMG showed a positive correlation with CSI and the narrowing of each coronary branch, while no relationship was noted between the LML and CSI.

Additional Indexing Words:

Left main coronary artery (LM) The grade of narrowing in LM

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(LMG) Myocardial infarction due to LM lesion The length of LM (LML) Coronary artery dominance

Various studies\(^1\)-\(^3\) have shown that severe narrowing of the left main coronary artery (LM) induces refractory angina pectoris and/or myocardial infarction. In such cases surgical treatment has been recommended which has shown better prognosis compared with medical treatment.\(^4\)-\(^6\)

However, narrowing of the LM in the aged has not been fully studied. It was assumed that severe narrowing of the LM might be rare in the aged, because it could not be compatible with survival until old age. Therefore, one purpose of this study was to evaluate the grade of narrowing of the LM in the aged.

Moreover, general information on the length of the LM is limited. The relationship between the length and the degree of stenosis of the LM or the other branches of the coronary arteries has remained controversial, although Gazetopoulos et al\(^7\),\(^8\) reported that the length of the LM may bear an inverse relationship with the severity of stenosis. The second purpose of this study was to determine the length of the LM in the aged and to make clear the relationship between the length and lesions of the LM or the other coronary branches.

**Materials and Methods**

We examined the grade of narrowing in the LM (LMG) and the length of the LM (LML) in a total of 972 hearts (T) from consecutive autopsies performed at the Tokyo Metropolitan Geriatric Hospital, consisting of 503 men and 469 women aged 60-103 years (mean: 79.0 years). Lesions in the LM were grossly determined by inspection of cross-sections every 2 mm. The ex-

\[
\text{LMG} : \text{Grade 0; none, Grade 1; 10\%}, \\
\text{Grade 2; 25\%}, \text{Grade 3; 50\%}, \\
\text{Grade 4; 75\%}, \text{Grade 5; 100\%}
\]

Fig. 1. Method of this study. \(A_o=aorta; AV=aortic valve; RCA=\) right coronary artery; \(LM=left\) main coronary artery; \(LAD=left\) anterior descending coronary artery; \(LCX=left\) circumflex coronary artery; \(LML=\) length of the LM; \(LMG=grade\) of narrowing in the LM.
tent of narrowing was graded from 5 to 0 according to the modified method of estimation of the coronary stenotic index (CSI)\(^{9,10}\): 5 = complete occlusion, 4 = 75% stenosis, 3 = 50% stenosis, 2 = 25% stenosis and 1 = minimal stenosis (Fig. 1). The length of the LM was measured from the coronary ostium to the bifurcation of the left anterior descending coronary artery (LAD) and the left circumflex coronary artery (LCX) as illustrated in Fig. 1. The relationship between the LML and coronary dominance was also evaluated. Coronary dominance was grossly determined by the distribution of coronary arteries in an individual heart. Among 972 cases a total of 141 normal hearts (N) were selected, because they were free from any heart disease based on clinical and pathologic findings. This group consisted of 56 men and 85 women with an average age of 77.0 years. A total of 202 cases (MI) having myocardial infarction by pathologic examination which showed myocardial fibrosis or necrosis of more than 20 mm in diameter, were also selected from the 972 cases. They consisted of 108 men, 94 women with an average age of 79.6 years. The LM lesions were also compared between these 2 groups. The values are expressed as means±standard deviations. Statistical analyses were made by Student’s t-test, and the Pearson correlation method using SPSSX on a DEC VAX-11 computer system.

**Results**

1. General pathologic findings of the heart

The average heart weight was 329.2±92.6 g in the whole (T) group, 269.6±41.0 g in the normal (N) and 382.5±99.0 g in the myocardial infarction group (MI). There was a significant difference between N and MI (p<0.001). The average CSI was 9.1±2.9/15 in T, 5.9±1.8/15 in N and 11.4±1.8/15 in MI (MI>N, p<0.001).

2. The grade of narrowing in the left main coronary artery (LMG)

The average LMG, shown in Table I, was 1.8±0.9/5 in T, 1.3±0.6/5 in N and 2.3±1.1/5 in MI. There was a significant difference between N and MI (p<0.001) and there was also a sex difference for the total group (p<0.02). Figure 2 illustrates the distribution of the LMG in all 971 cases on the left side, showing a narrowing of Grade 1 or 2 in most cases. On the right side of Fig. 2 the distribution of the LMG in N and MI groups is shown revealing a higher grade of the LMG in the MI compared to the N group (p<0.001). Grades 4 and 5 were found in 58 cases (6%) of the total of 972 cases, of which 35 (60%) belonged to the MI group, but myocardial infarction caused directly by the atherosclerotic stenosis of the LM was proved in only 9 (4.5%
Table I. Average Grade of the Narrowing of the Left Main Coronary Artery (LMG) in Total (T), Normal (N) and Myocardial Infarction (MI) Groups

<table>
<thead>
<tr>
<th></th>
<th>T (n = 871)</th>
<th>N (n = 141)</th>
<th>MI (n = 202)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>1.8 ± 0.9</td>
<td>1.3 ± 0.6</td>
<td>2.3 ± 1.1</td>
</tr>
<tr>
<td>Male</td>
<td>1.8 ± 1.0†</td>
<td>1.3 ± 0.5‡</td>
<td>2.3 ± 1.1§</td>
</tr>
<tr>
<td>Female</td>
<td>1.7 ± 0.9§</td>
<td>1.2 ± 0.6</td>
<td>2.2 ± 1.1‡</td>
</tr>
</tbody>
</table>

☆ p < 0.001

There is a significant difference between N and MI (N < MI, p < 0.001).

Distribution of LMG

Fig. 2. Distributions of LMG in all cases (T) (left side) and in normal (N) and myocardial infarction (MI) groups (right side). F = female; M = male.

among all MI) determined by pathologic evaluations. Those 9 cases are listed in Table II. There were 3 cases with Grade 5 including 1 case associated with a fresh thrombosis in the LM and 6 patients with Grade 4. These 9 cases showed cardiac death and had associated 3-vessel disease, but angina pectoris was documented in only 3 patients. The characteristics of MI were fresh, massive and large (more than 5 cm in diameter) necrotic lesions except in Case 1 which had an old (healed), scattered and large MI. In addition, transmural MI was found in 3 and subendocardial MI in 5 cases. Figure 3 illustrates the relationship between the LMG and age in individual groups.
### Table II. Nine Cases of MI Due to LM Stenosis

<table>
<thead>
<tr>
<th>No.</th>
<th>Age</th>
<th>Sex</th>
<th>A.P.</th>
<th>ECG</th>
<th>LM stenosis</th>
<th>Pathology of MI</th>
<th>Site</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>72</td>
<td>F</td>
<td>+ OM1</td>
<td>Master(+)</td>
<td>99% Old</td>
<td>Scat. Large Trans</td>
<td>Ant-Sept1</td>
</tr>
<tr>
<td>2</td>
<td>76</td>
<td>M</td>
<td>- LVH</td>
<td>100%</td>
<td>Fresh Mass. Large Trans</td>
<td>Ant-Sept-Lat</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>75</td>
<td>M</td>
<td>High vol.</td>
<td>75%</td>
<td>Fresh Mass. Large S.E.</td>
<td>Circ.</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>58</td>
<td>F</td>
<td>+ 1’ A-V B. Master(+)</td>
<td>100%</td>
<td>Fresh Mass. Large S.E.</td>
<td>Ant-Sept-Post</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>60</td>
<td>F</td>
<td>+ W.N.L. Master(+)</td>
<td>90%</td>
<td>Fresh Mass. Large S.E.</td>
<td>Circ.</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>73</td>
<td>M</td>
<td>High vol. Master(+)</td>
<td>75%</td>
<td>Fresh Mass. Large Trans</td>
<td>Ant-Sept-Lat</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>77</td>
<td>M</td>
<td>- W.N.L.</td>
<td>80%</td>
<td>Fresh Mass. Large S.E.</td>
<td>Circ.</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>84</td>
<td>F</td>
<td>- LVH</td>
<td>75%</td>
<td>Fresh Mass. Large S.E.</td>
<td>Circ.</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>78</td>
<td>M</td>
<td>- W.N.L.</td>
<td>90%</td>
<td>Fresh Mass. Large Trans</td>
<td>Ant-Sept Post, RV</td>
<td></td>
</tr>
</tbody>
</table>

A. P. = angina pectoris; ECG = electrocardiogram; F = female; M = male; OMI = old myocardial infarction; LVH = left ventricular hypertrophy; volt. = voltage; A-V B. = atrioventricular block; W.N.L. = within normal limit; Scat. = scattered; Trans = transmural; Mass. = massive; S.E. = subendocardial; Ant = anterior; Sept = septal; Lat = lateral; Circ = circumferential; Post = posterior; RV = right ventricle.

### LMG and Age

![Graph showing relationship between LMG and age in T, N and MI groups.](image.png)

Fig. 3. Relationship between LMG and age in T, N and MI groups.

Only in the T group was there a slight positive correlation \((r=0.10, p<0.05)\).

3. The length of the left main coronary artery (LML)

The average LML was 9.4±4.4 mm in T, 9.0±4.2 mm in N and 9.3±3.8 mm in MI groups. There was no significant difference between N and MI or between sexes (Table III). Table IV shows the LML by type of dominant coronary artery. The LML in the left dominant type \((n=82, 8.4\%)\)
Table III. Average Length of the Left Main Coronary Artery (LML) in Total (T), Normal (N) and Myocardial Infarction (MI) Groups

<table>
<thead>
<tr>
<th></th>
<th>T (n=972)</th>
<th>N (n=141)</th>
<th>MI (n=202)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>9.4±4.4mm</td>
<td>9.0±4.2mm</td>
<td>9.3±3.8mm</td>
</tr>
<tr>
<td>Male</td>
<td>9.3±4.4</td>
<td>9.7±4.6</td>
<td>9.4±3.9</td>
</tr>
<tr>
<td>Female</td>
<td>9.5±4.5</td>
<td>8.5±3.8</td>
<td>9.1±3.8</td>
</tr>
</tbody>
</table>

Male vs Female (n.s.), N vs MI (n.s.)

Table IV. Relationship between the LML and the Coronary Dominant Types

LML and Coronary Type

- Rt. dominant (n=729): 9.7±4.4mm
- Lt. dominant (n=82): 8.5±4.0mm
- Balanced (n=159): 8.8±4.6mm

Cases with left coronary dominant type or balanced type show a significantly shorter LML than cases with right coronary dominant type (p<0.05).

Fig. 4. Distribution of LML in all cases (T). F=female; M=male.
Table V. Pearson Correlations between the LMG, the LML and Various Factors

<table>
<thead>
<tr>
<th>Correlations</th>
<th>Age</th>
<th>Heart</th>
<th>CSI</th>
<th>RCA</th>
<th>LAD</th>
<th>LCX</th>
<th>LMG</th>
<th>LML</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>+</td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
</tr>
<tr>
<td>LML</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>++</td>
<td>+++</td>
</tr>
<tr>
<td>N</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>++</td>
<td>n.s.</td>
</tr>
<tr>
<td>LMG</td>
<td>n.s.</td>
<td>n.s.</td>
<td>+++</td>
<td>n.s.</td>
<td>+++</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>LML</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>+</td>
<td>n.s.</td>
<td>n.s.</td>
<td>++</td>
<td>n.s.</td>
</tr>
<tr>
<td>MI</td>
<td>n.s.</td>
<td>n.s.</td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
</tr>
</tbody>
</table>

T=total group; N=normal group; MI=myocardial infarction group; CSI=coronary stenotic index; RCA=right coronary artery; LAD=left anterior descending coronary artery; LCX=left circumflex coronary artery. Significant correlations were found for ++ marks.

and the balanced type (n=159, 16.4%) was shorter than that in the right dominant type (n=729, 75.2%). Figure 4 illustrates the distribution of the LML in a total of 972 cases (T). There were 191 cases (20%) with LML of less than 5 mm, 461 cases (47%) with LML of from 5 to 10 mm and 71 cases (7.3%) of more than 15 mm.

4. Correlations between the LML and other factors

Table V shows the correlations between the LMG, the LML on the one hand and the age, heart weight, CSI and the degree of narrowing in 3 coronary arteries on the other hand. There was a positive correlation between the heart weight and the LMG in the T group. The correlations between the LMG and CSI, and the degree of narrowing of 3 coronary arteries were strongly noted in all groups, but there was no significant correlation between the LML and CSI.

DISCUSSION

The grade of narrowing in the left main coronary artery (LMG):

Those cases with severe narrowing of the LM were associated with a higher incidence of more severe forms of angina, especially crescendo angina. Cases with unstable angina demonstrated LM disease in 12% to 17.5%, although the overall prevalence is approximately 5% of all catheterized patients with coronary heart disease. In the treatment of angina or myocardial infarction associated with LM disease, coronary artery bypass surgery has been shown to have an unequivocally better prognosis than medical
therapy. For example, the Cleveland Clinic Group estimated 5 year survival to be 88.2%, following surgery compared with 51% for similar patients on medical management. Crittin et al. found severe narrowing of the LM to be prevalent in younger patients, 3.4% in men and 7.2% in women under 45 years of age. It was frequently isolated in younger women compared with multivessel disease in men. As to the total occlusion of the LM, Crosby et al. reported a 0.76% prevalence of total LM lesions. Zimmern et al. reported a 0.05% incidence among 23,349 patients entered into the Coronary Artery Surgery Study. In 1976, Bulkley and Roberts reported a pathologic study focusing on the LM coronary artery in 152 necropsy patients with coronary heart disease. They found LM with 75% narrowing in 35 patients and marked stenotic lesions were also found in the 3 other major coronary arteries. They concluded narrowing of the LM usually indicated severe narrowing of all major coronary arteries.

Data on the narrowing of the LM in the aged have not been fully obtained. Therefore, in this study to evaluate lesions of the LM among the aged regardless of their underlying diseases, we first analyzed 972 consecutive autopsy hearts as (T) group, and subsequently to clarify the difference in LM lesions between normal hearts (N) and cases of myocardial infarction (MI), we also analyzed 141 normal hearts and 202 hearts with MI selected from the (T) group. It was assumed that severe narrowing of the LM in the aged might be rare, because cases having severe LM disease generally could not survive until old age. In our study the average degree of narrowing of the LM was from 10% to 25% in most aged cases, and severe narrowing of more than 75% appeared in only 6% of the aged. In addition, 9 cases developed myocardial infarction directly caused by LM disease, which was 4.5% of all MI cases. These results might support our assumption that in the aged severe narrowing of the LM might be rare. However, the degree of LM narrowing (LMG) was more severe in aged cases of MI, compared with normal aged (N). The relationship between the LMG and CSI or the severely stenotic coronary artery branches revealed a significant correlation. This finding was similar to that of Bulkley and Roberts.

The length of the left main coronary artery (LML):

Although many investigations of the narrowing of the LM have been done, knowledge of the length of the LM (LML) is limited. In 1961, James noted that the LML ranged from 2 mm to 40 mm. In 1967, Green et al. studied the LML among autopsy hearts and reported that the average LML was 11.4 mm, with 24% of them less than 5 mm. On the other hand, in 1973 Fox et al. claimed that the LML was 5.5 mm on average and that most
cases were less than 6 mm. But other studies\textsuperscript{7),8,19)-21} including ours revealed that the average LML is about 10 mm.

We could not find any reports of the LML in the aged. In this study we found that the average LML in the aged was 9.4±4.4 mm, regardless of concomitant diseases.

Cases with a left dominant coronary artery have been reported to show a shorter LML than that of cases with a right dominant coronary artery.\textsuperscript{19} Johnson et al\textsuperscript{22} reported that cases with a congenital aortic bicuspid valve and/or a left dominant coronary artery showed a significantly shorter LML. However, Virmani et al\textsuperscript{21} did not find any significant relationship between a short LML and coronary dominance or aortic bicuspid valve. Lerer and Edwards\textsuperscript{23} also did not find any difference in the LML between cases with congenital bicuspid aortic valve and acquired tricuspid aortic valve, while they found a shorter LML in cases with left artery dominance or a shared dominant coronary artery. This latter fact corresponded to our study, in that cases with left dominant or balanced coronary artery type the LML was significantly shorter than that with a right dominant coronary artery.

\textit{Relationship between LML and LMG or the other 3 main coronary arteries:}

In 1976 Gazetopoulos et al\textsuperscript{7,8} claimed that a short left coronary artery trunk might be related to the development of coronary atherosclerosis from both coronary arteriographic and pathologic studies. However, in our study there was neither a relationship between the LML and the coronary stenotic index (CSI), nor between the LML and the narrowing of each coronary branch. There was a positive correlation between the LMG and the LML, especially in males with MI.

In conclusion, the grade of narrowing in the LM (LMG) in the aged was generally mild and the LMG showed a positive correlation to CSI and the narrowing of each coronary arterial branch, while no relationship between the LML and CSI was noted.

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