The Relationship of the Degree of Coronary Atherosclerosis with Age, in Men

By Neil K. White, M.D., Jesse E. Edwards, M.D., and Thomas J. Dry, M.B.

The amount of coronary atherosclerosis in each decade from 30 to 89 years of age, in the male, is evaluated. A large number of hearts were examined in great detail to increase accuracy. The results reveal that the degree of coronary atherosclerosis is not primarily related to age as is commonly assumed. The effect of cardiac hypertrophy on coronary atherosclerosis is also discussed.

The literature has consistently stressed the opinion that coronary atherosclerosis, as evaluated from necropsy studies, increases in severity with advancing age. The data, forming the basis of these opinions, in most instances have been derived from necropsy protocols. As a rule, the persons concerned in recording the data for any one report are many and their interest and experience in the study of the coronary arteries vary. Thus, in any one group of cases reported there may be considerable lack of uniformity in interpretation of observations. It is evident that a study performed by one individual would yield more uniform interpretations from case to case. Accordingly, a restudy was made of the degree of coronary atherosclerosis in the hearts of 100 consecutive men from each of the decades from age 30 through 89 years; a study totaling 600 hearts.

Material and Methods

The hearts used in this study had been saved at the time of necropsy as a routine procedure without regard to whether or not cardiac disease was present. The specimens had been obtained from routine consecutive necropsies on men and represented persons dying from many and varied causes. Those dying of disease of the coronary arteries or any other disease were not excluded. One hundred hearts from each of the six decades starting with the age of 30 years were used in this study. All of the subjects were men.

A method of examination was outlined by which a complete picture of the degree of coronary sclerosis in all parts of the coronary tree could be determined. This entailed the separation of the coronary tree in each heart into the following divisions for the purpose of recording sclerosis. The left coronary artery was divided into the left main coronary stem, the anterior descending branch, and the circumflex branch. The right coronary artery was divided into the right main coronary stem, the marginal branch, and the posterior descending branch. Each of these divisions was then subdivided into proximal, middle, and distal parts, except the left main coronary stem, which is usually 1 to 3 cm. in length and is too short for subdivision. This division of the coronary system is pictured in figure 1.

Each of the 600 hearts had, then, sixteen subdivisions of the coronary arteries which were separately evaluated for the degree of sclerosis. Cross sections were made with a sharp knife at 3-mm. intervals from the ostia to the terminal pericardial branches. Each section was carefully examined and its lumen was visualized. This method, it was felt, would provide an accurate picture of the amount of sclerosis for the entire coronary system.
The actual grading was on a basis of Grade 1 (minimal sclerosis) to Grade 4 (complete atherosclerotic closure of the lumen). The microphotographs shown in figure 2 are average selections from each of the four grades of sclerosis as standardized for this study.

The maximal degree of sclerosis as found in each of the sixteen segments was the recorded sclerosis for that segment.

With this information recorded, the average grade of sclerosis was then determined for each of the sixteen segments for the 100 consecutive hearts in each decade. This average grade of sclerosis formed the basis for the construction of figures 3 through 9. It should be clearly understood that these figures do not represent the changes in degree of atherosclerosis in an individual heart as age increases, but are the average results obtained from the study of necropsy material.

Figure 3 presents the findings in the left main coronary stem from the ostium in the left aortic sinus to its division into the anterior descending and circumflex branches. This segment is seldom more than 3 cm. in length. The average grade of sclerosis in this segment increases from Grade 1.58 during the age period of 30 through 39 years to an average of Grade 2.42 during the age period of 50 through 59 years. The greatest amount of sclerosis was found in the sixth decade with a slight decrease in subsequent decades.

The findings in the anterior descending branch of the left coronary artery are presented in figure 4. In general the curves are similar to those found for the left main coronary stem. The proximal segment of the anterior descending branch showed a higher average grade of sclerosis than any of the other fifteen segments studied. The age period in which the maximal sclerosis was present was again the 50-year through 59-year period, with less sclerosis in the succeeding decades. In every age period the average sclerosis in the middle segment was less than in the proximal, and the average sclerosis in the distal was less than in the middle segment.

Figure 5 presents the findings in the circumflex branch of the left coronary artery. The results are similar to those for the anterior
descending branch, except that the average grade of sclerosis was somewhat lower. The decade having the most sclerosis was the 50-year through 59-year age group. The average
sclerosis in the proximal segment of the circumflex branch in this decade was Grade 2.68 as compared to Grade 3.00 for the anterior coronary artery from the ostium in the right aortic sinus to the posterior longitudinal sulcus, at which point the right coronary artery continues as the posterior descending branch. The curves in general are similar to those noted in the left coronary artery and its major branches. The maximal grade of sclerosis was present in the 50-year through 59-year group. The segment of the right main coronary stem having the greatest degree of sclerosis was the middle branch. As in the case of the latter branch, the middle and distal segments of the circumflex branch showed less severe sclerosis than did the proximal segment.

Figure 6 presents the findings in the right main coronary stem. In this instance, the right main coronary stem represents all of the right descending branch. As in the case of the latter branch, the middle and distal segments of the circumflex branch showed less severe sclerosis than did the proximal segment.

**Fig. 3.**—The average grade of coronary sclerosis in the left main coronary stem (proximal to the point of division into the anterior descending branch and the circumflex branch) for 600 hearts according to decades studied.

**Fig. 4.**—The average grade of coronary sclerosis in the three segments of the anterior descending branch of the left coronary artery for 600 hearts according to decades studied.
segment—or more specifically, that segment extending from a point approximately 3.5 cm. from the ostium to another point about 7 cm. from the ostium. It should be noted that the

Figure 7 presents the findings in the marginal branch of the right coronary artery. This is usually the smallest of all the so-called main branches of the coronary arteries, and cor-

Figure 5.—The average grade of coronary sclerosis in the three segments of the circumflex branch of the left coronary artery for 600 hearts according to decades studied.

degree of sclerosis found was only a little less than in the anterior descending branch of the left coronary artery. The general pattern of degree of sclerosis was identical. It would seem that there are no inherent differences in the development of atherosclerosis in the left and right coronary arteries.

respondingly had the least degree of sclerosis. The maximal amount of sclerosis was found in the proximal segment of this artery in the 50-year through 59-year age group.

Figure 8 presents the results of the study of the posterior descending coronary artery. There were no variations noted from the previous findings. This artery is slightly larger than the
right marginal branch and has a higher average grade of sclerosis. The average grade of sclerosis in the last two arteries named never reaches more than a moderate amount (Grade 2). This is not a surprising finding, inasmuch as both represented the terminal portion of the right coronary artery.

Figure 9 is a composite to compare the maximal degree of sclerosis found in the six main branches of the coronary arteries. The curves

![Graph](image)

**Fig. 7.**—The average grade of coronary sclerosis in the three segments of the marginal branch of the right coronary artery for 600 hearts according to decades studied.

![Graph](image)

**Fig. 8.**—The average grade of coronary sclerosis in the three segments of the posterior descending coronary artery for 600 hearts according to decades studied.

the marginal and posterior descending arteries are relatively small branches, and merely follow the general trend of the grade of sclerosis decreasing toward the distal portion of the artery. Among the 600 hearts of this study the posterior descending coronary artery represented the terminal portion of the left circumflex artery in 45 cases; in the other 555 cases this artery show an average grade of sclerosis slightly greater than those noted in the previous figures. This is readily understood, inasmuch as the greatest amount of sclerosis found along the entire course of the branch, whether in its proximal, middle, or distal segment, was the grade used to determine these averages.

The main points emphasized by this repre-
sentation are that a careful examination of the coronary arteries reveals a rather severe degree of sclerosis at some point along the main arteries after the age of 49 years, and that the degree of sclerosis in the right main coronary stem and in the circumflex branch of the left coronary artery is only slightly less than that in the anterior descending branch.

In figure 10 the degree of sclerosis in each decade is studied from a different viewpoint. We wished to find the percentage of hearts in each decade in which there was a severe involvement of the coronary arteries. By our method of grading, this would include all coronary arteries with a grade of sclerosis of 3 or more (see fig. 2). The line in figure 10 marked "right" gives the percentage of hearts, in each decade, in which there was sclerosis of Grade 3 or more at some point in the right coronary artery or its ramifications. The line marked "left" shows the percentage of hearts, in each decade, in which there was sclerosis of Grade 3 or more in the left coronary artery plus the relatively few hearts in which there was sclerosis of Grade 3 or more in the right coronary artery with less than Grade 3 sclerosis in the left coronary artery.

In this regard it was found that 11 per cent of the hearts in the 50-year through 59-year period had sclerosis of Grade 3 or more in the right coronary artery, with less than Grade 3 sclerosis in the left coronary artery. Clawson found this relationship in only 1 per cent of the 928 cases of coronary sclerosis of all ages that he reported in 1939.

According to Clawson, hypertension pre-
of coronary atherosclerosis and age

Table 1—The average of the maximal grade of sclerosis found in each of the main coronary arteries according to decade: hearts weighing less than 450 grams

<table>
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<tr>
<th>No. of hear…</th>
<th>76</th>
<th>69</th>
<th>63</th>
<th>64</th>
<th>61</th>
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<td>50–59</td>
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<td>2.63</td>
<td>2.67</td>
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<td>2.06</td>
<td>1.98</td>
<td>1.71</td>
<td>1.77</td>
</tr>
</tbody>
</table>

Table 1.—The average of the maximal grade of sclerosis found in each of the main coronary arteries according to decade: hearts weighing less than 450 grams.

The average of the maximal grade of sclerosis found for each artery and for each decade is given in tables 1 and 2.

Fig. 10—The percentage of cases in each decade in which there was maximal sclerosis of Grade 3 or more in either the right or the left coronary artery; the percentage of cases in which there was sclerosis of Grade 3 or more in the left coronary artery, and the percentage of cases in which there was sclerosis of Grade 3 or more in the right coronary artery.
The hearts weighing 450 grams or more consistently showed a slightly greater degree of coronary sclerosis than those weighing less than 450 grams, but the actual amount of sclerosis is seldom more than 10 per cent greater in the hearts weighing 450 grams or more than in those weighing less than 450 grams for corresponding coronary arteries and decades. It is certain that the myocardium of the hypertrophied heart is affected to a much greater degree than indicated by the slightly increased amount of sclerosis, inasmuch as its oxygen demand increases as hypertrophy develops. Therefore, the hypertrophied heart will succumb to coronary arterial disease before the heart of the normal size if both have an equal grade of coronary sclerosis. As mentioned previously, the hearts weighing 450 grams or more showed about 5 to 10 per cent greater degree of sclerosis than the hearts weighing less than 450 grams. This would further accentuate the myocardial anoxemia.

**Comment**

The main purpose of this study was to determine whether the average grade of coronary sclerosis, as observed in necropsy material, increases progressively with age, as has been repeatedly stated in the literature. The present series failed to substantiate this contention. It was found that the average grade of sclerosis in each of the sixteen subdivisions of the coronary tree for which an evaluation was made, followed a similar pattern when related to age. In all instances the average grade of sclerosis rose steadily with age from the first period studied, 30 through 39 years of age, to a maximal rather severe average grade of sclerosis in the 50-year through 59-year age group. Beyond this age group the average grade of sclerosis did not increase.

In our series in 18 per cent of the hearts in the 30-year through 39-year age group sclerosis of Grade 3 or more affected some part of the coronary tree. French and Dock\(^4\) investigated 80 cases of fatal coronary disease in soldiers between the ages of 20 and 36 years. Seventy of the 80 patients died within a few minutes after the onset of the attack. In these hearts adequate collateral circulation had not as yet developed. Sudden death of this nature is much less common after the age of 50 years than before that age. This definitely suggests that the collateral coronary circulation develops as the degree of sclerosis increases and according to our findings would be well established by the sixth decade.

**Conclusions**

1. Six hundred hearts, consisting of a series of 100 consecutively chosen hearts of men in each of the six decades from 30 through 89 years of age, were thoroughly examined for the amount of coronary sclerosis. It has been shown that the degree of coronary sclerosis in necropsy material is not linearly related to age, but increases rapidly in the 30-year through 49-year age period, reaches a maximum in the 50-year through 59-year age group, and thereafter remains at a fairly constant level.

2. Beyond the age of 49 years, the average man at the time of death has a rather severe degree of coronary atherosclerosis—amounting to a Grade 3 sclerosis (on a basis of Grade 1 to Grade 4) at some point in both the left and right coronary arteries.

3. Hypertension—as revealed by myocardial hypertrophy—is not a primary factor in the production of coronary atherosclerosis. The average grade of sclerosis in the hearts weighing 450 grams or more was less than 10 per cent greater than in the hearts weighing less than 450 grams.

4. The pattern of development of sclerosis in the right coronary artery is similar to that
found in the left coronary artery, and does not seem to justify the conclusion that there are inherent differences in the manner of development of sclerosis in the two arteries. The proximal segment of the anterior descending branch of the left coronary artery had the highest average grade of sclerosis of any of the sixteen segments studied. However, the degree of difference between this segment and corresponding segments of the right main coronary stem was not striking.

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