Clinical and necropsy findings in patients with calcified myocardial infarcts

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Clinical and necropsy findings are described in 37 patients with grossly visible myocardial infarcts. At the time of the first infarct, the 31 men ranged in age from 25 to 72 years (mean, 47) and the 6 women, from 50 to 70 years (mean, 56). The interval from the first clinically apparent acute myocardial infarct to death varied from 2 to 28 years (mean, 13) and was ≥10 years in 24 of 32 patients (75%) for whom this information was available. The ages of death in the 31 men ranged from 39 to 75 years (mean, 61), and in the 6 women, from 62 to 75 years (mean, 69). The ages of death in the 9 patients having coronary bypass grafting was insignificantly different from that in the 28 patients not having this procedure. Most had chronic heart failure (73%), which was the most common mode of death. Nearly all had dilated left ventricular cavities, with left ventricular aneurysms in 43%. The hearts were increased in weight in 94%, and all had severe coronary arterial atherosclerosis. Thus, patients with calcified myocardial infarcts are usually men, the infarct that calcifies usually occurs at a relatively young age (mean, 50), the calcified wall is often aneurysmal, the left ventricular cavity is almost always dilated, the heart weight is increased, and heart failure is the predominant symptom and most common mode of death.

Calcific deposits often are observed in the hearts of older persons living in developed countries. These deposits are most commonly located in atherosclerotic plaques in the coronary arteries, in the mitral annulus, in the aortic valve cusps, and in the left ventricular papillary muscles (1). Stenotic mitral and aortic valves in adults are usually calcified (2, 3). Certain clinical and autopsy findings in 21 patients with grossly visible calcific deposits at sites of healed myocardial infarcts have been previously reported by one of us (WCR) (4). There have been no published reports on this topic since that publication in 1987. Since 1987, we have collected an additional 16 cases. This article summarizes clinical and necropsy findings in these 37 patients with calcified myocardial infarcts and compares findings in those having vs those not having coronary artery bypass grafting (CABG).

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Certain clinical and necropsy findings in the 37 patients are summarized in *Tables 1–3*. All 37 hearts were examined by one of us (WCR). The cases were divided into 2 groups based upon whether or not the patient had CABG.

Non-CABG group: These 28 patients ranged in age from 39 to 78 years (mean, 62); 23 (82%) were men and 5 (18%) were women. Twenty-four had a history of ≥1 clinically apparent acute myocardial infarct, 17 (71%) with a single infarct and 7 (29%) with ≥2 infarcts. The interval between the first clinically apparent infarct and death in these 24 patients ranged from 2 to 28 years (mean, 13). The ages at first acute myocardial infarct ranged from 25 to 72 years old (mean, 48). Two of the 4 patients with clinically silent infarcts (cases 13 and 22) had previous electrocardiograms consistent with healed myocardial infarction.

CABG group: These 9 patients at death ranged in age from 42 to 75 years (mean, 65); 8 (89%) were men and 1 (11%) was a woman. All 9 patients had a history of ≥1 clinically apparent acute myocardial infarcts, 2 patients with a single infarct and 7 patients with ≥2 infarcts. The interval between the first infarct and death ranged from 10 to >20 years (mean, 14). The ages at the first infarct spanned from 32 to 61 years (mean, 50) in the 8 patients whose ages at the first infarct are known. One of these 9 patients (case 9) had a history of 3 acute myocardial infarcts, including one at the time of his CABG 20 years before death.

In both groups, heart failure was the most common manifestation of cardiac disease: 20 of the 28 non-CABG cases (71%) had evidence of chronic heart failure, and 7 of the 8 remaining patients (cases 6, 7, 10, 13, 14, 18, and 24) had dilated left ventricular cavities at autopsy, including 2 with true left ventricular aneurysms (cases 13 and 24). Of the 9 CABG cases, 7 had evidence of heart failure, and the 2 remaining patients (cases 7 and 9) had dilated ventricles, including 1 with a true left ventricular aneurysm. Heart failure also was the most common mode of death in both groups (Table 3).

Of the 28 patients in the non-CABG group, 12 (43%) had true left ventricular aneurysms, and 5 had intraaneurysmal thrombus. Of the 16 patients in this group without aneurysms, 3 had thrombus in the left ventricular cavity at autopsy. In the CABG group, 4 patients (44%) had left ventricular aneurysms at autopsy, including 1 with intraaneurysmal thrombus.

All 37 patients had >75% reduction in cross-sectional area by atherosclerotic plaque in at least one major epicardial coronary artery and usually in ≥2 major arteries.

Photographs of several calcified myocardial infarcts are shown in *Figures 1–4*.

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Table 1. Calcified myocardial infarcts at autopsy among patients without coronary artery bypass grafting

Case	Age at death (yr)	Age at first AMI (yr)	Interval of first AMI to death (yr)	No. of AMIs	Gender	CHF	AP	VT	SH	DM	Stroke	Mode of death	HW (g)	Location of calcified infarct				LV aneurysm	LV T	Coronary artery decreased >75% in CSA by plaque			
														A	P	Apical	Basal			LM	LAD	LC	Right
1	39	30	9	2	M	+	+	+	0	0	0	AMI	615	+	0	+	+	+	+	0	+	+	+
2	43	37	6	1	M	+	0	0	0	0	0	CHF	610	+	0	+	+	+	0	- -	+	+	+
3	49	42	7	1	M	0	0	0	+	+	+	- -	480	0	+	+	0	0	0	- -	- -	- -	- -
4	50	36	14	1	M	+	+	+	0	0	0	AMI	480	+	0	+	+	+	0	- -	+	0	0
5	52	25	27	1	M	+	0	0	0	0	0	Sudden	680	0	+	+	+	0	0	- -	- -	- -	+
6	52	50	2	1	M	0	0	0	0	0	0	Suicide	475	+	0	+	+	0	0	- -	+	0	+
7	52	46	6	1	M	0	0	0	+	0	0	Sudden	510	+	0	+	+	0	+	- -	+	0	+
8	54	44	10	3	M	+	0	0	0	0	0	CVA	730	+	0	+	+	0	+	0	+	+	+
9	57	45	12	2	M	+	0	0	- -	0	0	Sudden	540	+	0	+	+	0	0	- -	+	0	+
10	57	43	14	1	M	0	0	+	+	0	0	HF	415	0	+	+	+	0	0	- -	+	0	+
11	60	- -	- -	- -	M	+	0	+	0	+	+	CHF	592	+	+	+	+	0	0	- -	+	- -	- -
12	62	50	12	1	F	+	0	0	+	0	0	CHF	405	+	+	+	0	+	+	- -	+	0	0
13	62	- -*	- -	- -	M	0	0	0	0	0	0	Cancer	500	0	+	+	+	+	0	- -	+	+	+
14	63	48	15	1	M	0	0	+	0	0	0	CVA	480	0	+	+	+	0	0	- -	- -	- -	- -
15	63	38	25	4	M	+	+	0	0	+	+	CHF	470	+	+	+	0	+	0	- -	+	+	+
16	63	61	2	1	M	+	0	0	+	0	0	CHF	790	+	0	+	0	+	+	- -	+	+	+
17	65	55	10	1	M	+	0	+	+	0	0	Sudden	570	+	0	+	0	+	+	0	+	+	0
18	66	- -	- -	- -	M	0	0	0	+	0	0	Sudden	570	+	0	+	+	0	+	- -	+	+	0
19	67	54	13	1	F	+	0	0	0	+	+	CVA	310	+	0	+	+	0	0	- -	+	- -	- -
20	67	45	22	1	M	+	0	0	0	0	0	CHF	430	+	0	+	+	+	0	- -	+	+	0
21	68	52	16	1	M	+	0	0	0	0	0	CHF	480	+	0	+	+	0	0	- -	+	+	+
22	70	- -†	- -	- -	M	+	+	0	0	0	0	Amyloidosis‡	430	0	+	0	+	0	0	0	+	0	+
23	74	62	12	1	F	+	+	+	+	0	0	AMI	- -	+	0	+	0	0	0	- -	+	+	+
24	75	47	28	2	F	0	+	0	+	0	0	Hip Fx	505	+	+	+	0	+	0	0	+	+	+
25	75	59	16	1	M	+	0	0	0	0	0	Infection	680	0	+	+	0	0	0	- -	+	+	+
26	75	70	5	1	F	+	0	+	+	0	0	CHF	660	0	+	0	+	+	0	- -	0	+	+
27	75	49	26	3	M	+	+	+	0	+	+	Hip Fx	700	0	+	+	+	0	0	- -	+	+	+
28	78	72	6	2	M	+	0	0	0	0	0	CHF	680	+	+	+	0	+	+	- -	+	0	0

*Electrocardiogram at age 43 was consistent with healed myocardial infarction.
†Electrocardiogram at age 67 was consistent with healed myocardial infarction.
‡No cardiac involvement.
A indicates anterior; AMI, acute myocardial infarction; AP, angina pectoris; CHF, chronic congestive heart failure; CSA, cross-sectional area; CVA, cardiovascular accident; DM, diabetes mellitus; Hip Fx, hip fracture; HW, heart weight; LAD, left anterior descending; LC, left circumflex; LM, left main; LV, left ventricular; P, posterior; SH, systemic hypertension; T, thrombus; VT, ventricular tachyarrhythmia; - -, no information available.

Table 2. Calcified myocardial infarcts at autopsy among patients having coronary artery bypass grafting

Case	Age at death (yr)	Age at first AMI (yr)	Interval of first AMI to death (yr)	Interval of CABG to death (yr)	No. of AMIs	Gender	CHF	AP	VT	SH	DM	Stroke	Mode of death	HW (g)	Location of calcified infarct: A	P	Apical	Basal	LV aneurysm	LV T	Coronary artery decreased >75% in CSA by plaque: LM	LAD	LC	Right
1	42	32	10	10	1	M	+	+	0	+	0	0	Sudden	735	+	+	+	+	0	0	+	+	+*	+
2	60	39	21	8	3	M	+	+	+	+	+	+	Stroke	695	+	+	+	0	+	+	+	+*	+*	+*
3	62	52	10	10	2	F	+	+	+	+	0	- -	CHF	610	0	+	0	+	0	- -	- -	+*	+*	+
4	63	51	12	8	1	M	+	+	+	0	0	0	CHF	- -	+	0	+	+	0	0	- -	- -	- -	- -
5	65	50	15	10	2	M	+	0	0	0	0	- -	CHF	610	+	0	+	+	+†	0	- -	+*	+	+
6	69	56	13	10	4	M	+	0	+	+	+	+	CHF	485	+	0	+	0	+†	0	0	+	+	+*
7	72	55	17	5	2	M	0	+	0	0	0	0	Cancer	390	0	+	0	+	+	0	0	+*	+*	+*
8	73	61	12	2 days	2	M	+	+	0	0	0	0	CHF	- -	+	0	+	+	0	0	+	+*	0	+*
9	75	- -	>20‡	20	3	M	- -	- -	- -	- -	0	0	Sudden	660	+	+	0	+	0	0	0	+*	- -	+*

*Artery bypassed.

†Aneurysm excised at time of CABG.

‡Known myocardial infarction at time of CABG.

A indicates anterior; AMI, acute myocardial infarction; AP, angina pectoris; CABG, coronary artery bypass grafting; CHF, chronic congestive heart failure; CSA, cross-sectional area; DM, diabetes mellitus; HW, heart weight; LAD, left anterior descending; LC, left circumflex; LM, left main; LV, left ventricular; P, posterior; SH, systemic hypertension; T, thrombus; VT, ventricular tachyarrhythmia; - -, no information available.

Table 3. Comparison of findings in patients with and without coronary artery bypass grafting

	Coronary artery bypass grafting: No (n = 28)	Yes (n = 9)
Age (yr) at death: range (mean)	39–78 (62)	42–75 (65)
Women/men	5 (18%)/23 (82%)	1 (11%)/8 (89%)
Single myocardial infarct	17 (61%)	2 (22%)
Mean interval between first AMI and death (yr)	13	14
Age (yr) at first AMI: range (mean)	25–72 (48)	32–61 (50)
Chronic heart failure	20 (71%)	7 (78%)
Angina pectoris	7 (25%)	7 (78%)
Ventricular tachyarrhythmia	9 (32%)	4 (44%)
Systemic hypertension	10 (36%)	4 (44%)
Diabetes mellitus	5 (18%)	2 (22%)
Stroke	4 (14%)	2 (22%)
Mode of death		
Heart failure	9 (32%)	5 (56%)
Sudden	5 (18%)	2 (22%)
AMI	3 (11%)	0
Stroke	3 (11%)	1 (11%)
Noncardiovascular death	7 (25%)	1 (11%)
Heart weight (g)		
Women: range (mean)	310–660 (470)	610
Men: range (mean)	415–790 (562)	390–735 (596)
Location of calcified infarct		
Anterior only	14 (50%)	4 (44%)
Posterior only	9 (32%)	2 (22%)
Anterior + posterior	5 (18%)	3 (33%)
Apical only	9 (32%)	2 (22%)
Basal only	2 (7%)	3 (33%)
Apical + basal	17 (61%)	4 (44%)
Left ventricular aneurysm	12 (43%)	4 (44%)

AMI indicates acute myocardial infarction.

In 1908, Simmonds first described a patient with a calcified myocardial infarct grossly visible at autopsy (5). Over the next 96 years, 53 additional autopsy cases of calcified myocardial infarct were reported, including 21 cases previously reported by one of us (5) and included herein. Thus, grossly visible calcific myocardial infarcts are uncommonly seen at necropsy.

CABG probably did not alter the natural history of patients with calcified infarcts in the present study. The average age at death in the 9 patients in the CABG group was 65 years compared with 62 years in the 28 patients in the non-CABG group. Similarly, the interval between first infarct and death did not differ between the 2 groups (13 years in the non-CABG group vs 14 years in the CABG group).

Among the 37 patients with calcified myocardial infarcts included in the present study, most (84%) were men. Most had their first acute myocardial infarct at a relatively young age (range, 25–72 years; mean, 49; median, 50); only 5 (16%) of the 32 for which the information was known were >60 years of age at the time of their first acute myocardial infarct, presumably the one that later calcified. The 6 women ranged in age at the time of their first infarct from 50 to 70 years (mean, 56), and the 26 men,

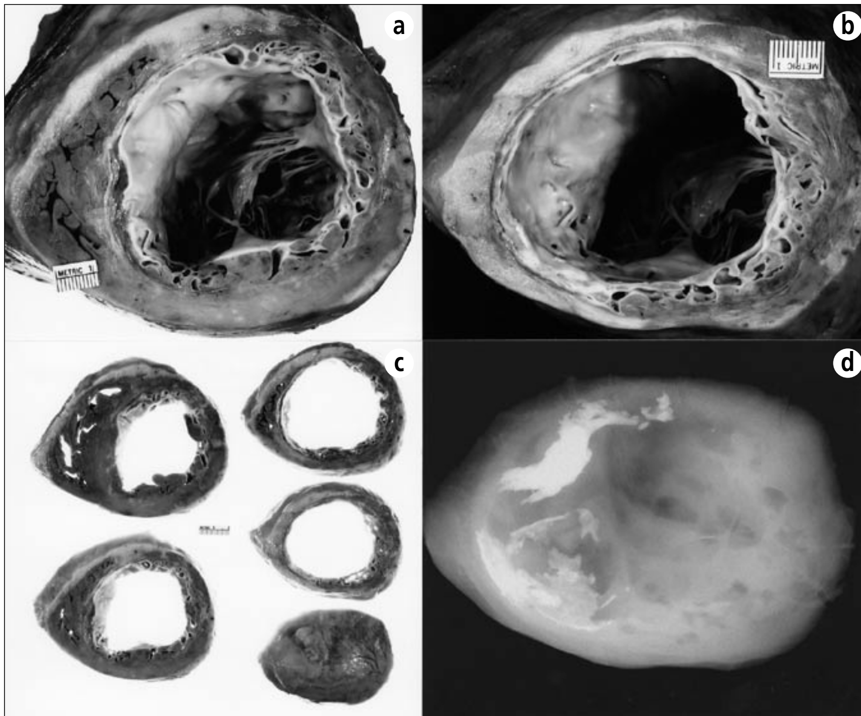

Figure 1. Case 1 in the coronary bypass group. Shown is the heart of a 42-year-old man who had had an acute myocardial infarct at age 32 and progressive heart failure thereafter. He died suddenly. **(a)** View of the left ventricular cavity from below showing marked dilatation and marked endocardial thickening and thinning of the ventricular septum. **(b)** A more apical view showing marked thinning of the left ventricular wall with heavy calcific deposits. **(c)** Views of slices of the ventricular walls showing marked left ventricular dilatation. **(d)** Radiograph of the heart specimen showing heavy calcific deposits primarily in the ventricular septum.

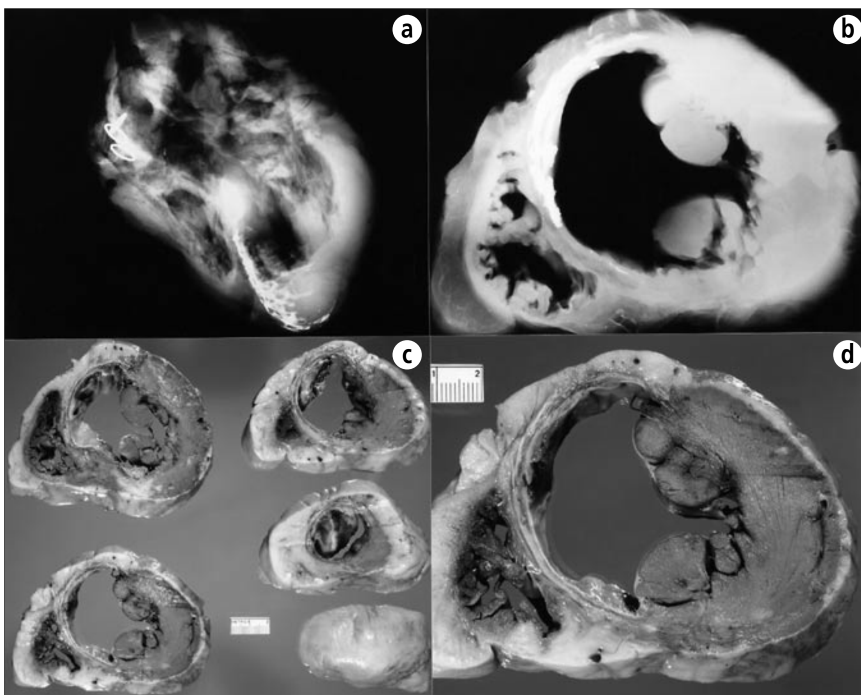

Figure 2. Case 2 in the coronary bypass group. This 60-year-old man had had an acute myocardial infarction at age 39 with chronic heart failure thereafter. He died of a stroke, presumably from embolic material originating in the left ventricular cavity overlying the calcified infarct. **(a)** Radiograph of the heart showing heavy calcific deposits in the anteroseptal wall. **(b)** Radiograph of one of the ventricular slices showing heavy calcific deposits in the anteroseptal wall. **(c)** Views of the ventricular walls showing marked thinning of the ventricular septum with heavy calcific deposits in that area with overlying thrombus in the more apical slices. **(d)** A close-up view showing the thinning of the anteroseptal wall with calcific deposits in the area of thinning.

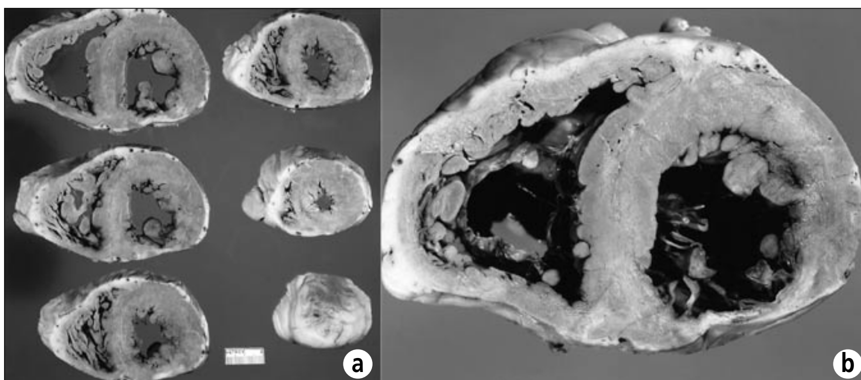

Figure 3. Case 22 in the noncoronary bypass group. This 70-year-old man had had an earlier infarct, but his age at the time was not known. He died of systemic amyloidosis rather than heart disease. There were no amyloid deposits in the myocardium. **(a)** Slices of the ventricular walls showing a healed infarct in the posterior portion of the left ventricular cavity. **(b)** A close-up view of the most basal portion of the ventricles. The posterior wall infarct is calcified. Both ventricular cavities are dilated.

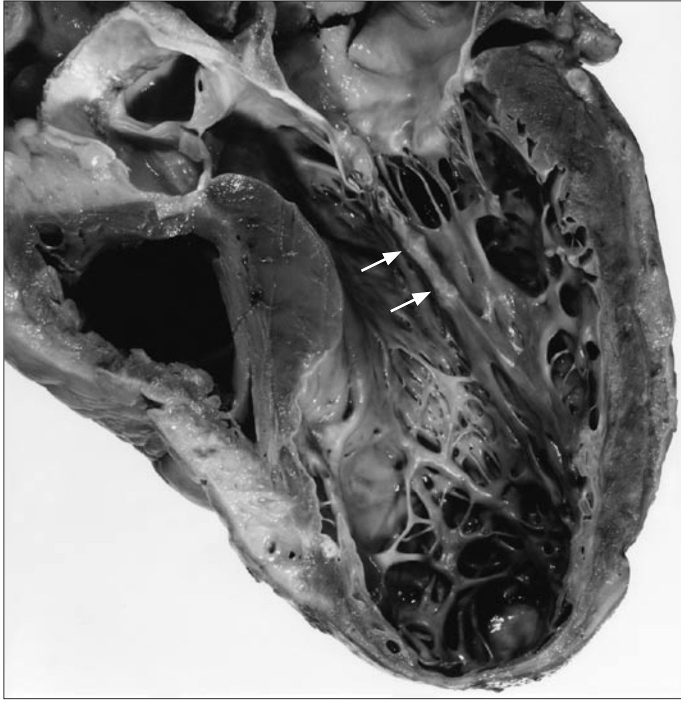

Figure 4. Case 24 in the noncoronary bypass group. The 75-year-old man whose heart is shown here had an acute myocardial infarction at age 47. The infarct involved the entire apical portion of the left ventricle, as well as the apical portion of the ventricular septum. A good bit of the infarcted wall is calcified. Calcium is also present in the posteromedial papillary muscle (arrows). The ventricular cavity is quite dilated. The patient died not from a cardiac condition but from consequences of a hip fracture.

from 25 to 72 years (mean, 47). Fifteen of the 26 men (58%) and only 1 of the 6 women were <50 years of age at the time of their first myocardial infarct.

The interval from the first acute myocardial infarction to death in the 32 patients for whom this information was available was much longer than in patients surviving acute myocardial infarction without calcification of the infarcted myocardium. The intervals ranged from 2 to 28 years (mean, 13.5) and were similar in both men and women, 13.5 and 13.3 years, respectively. Thus, calcification of a myocardial infarct takes time and, from a prognostic standpoint, appears to be a favorable development despite the frequent association of ventricular arrhythmias, cardiomegaly, and left ventricular aneurysm.

Malignant ventricular arrhythmias were documented in 13 of the 37 patients (35%). These arrhythmias are recognized to be especially common in patients with dilated left ventricular cavities, particularly in the presence of left ventricular aneurysms, and the latter were present in 16 of the 37 patients (43%). Virtually all of the 21 patients without left ventricular aneurysms had dilated left ventricular cavities.

The hearts at necropsy were increased in weight (>350 g in women and >400 g in men) in 32 (94%) of the 34 patients for whom this information was available. The hearts in the 29 men ranged in weight from 390 to 790 g (mean, 568) and in the 5 women, from 310 to 660 g (mean, 498). At least 14 of the 37 patients (38%) had had a history of "elevated blood pressure" in the past, but none appeared to have had "hypertension" in their later months of life. Probably, most of the 37 patients had had hypertension at some time, but reliable information on this point was not available to us.

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