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Determination of Serum Myoglobin Level After Death in the Diagnosis of Sudden Coronary Artery Occlusion

Toxicologic studies have become standard procedure in the investigation of medicolegal deaths and some biochemical parameters in the cadaver's blood may be useful in validating autopsy findings [*1*]. In our experience, the determination of lactic dehydrogenase (LDH), creatine phosphokinase (CPK), and glutamic oxalacetic transaminase (GOT) in serum has been useful in the evaluation of cardiac death when this occurs several hours to a few days after the occurrence of the cardiac catastrophe. However, the enzymatic cardiac parameters are of little impact when death occurs suddenly in apparently healthy individuals and acute coronary occlusion is the cause of death, since they do not show significant enough changes.

More recently, the determination of serum myoglobin has been recommended as a possibly useful and early index of acute myocardial damage. With the introduction of radioimmunoassays [*2*], its determination has become relatively rapid and inexpensive. A low molecular weight, oxygen-binding heme protein, myoglobin is formed only in cardiac and skeletal muscle of man [*3*] and exhibits rapid renal clearance. It appears in human serum a few hours after the occurrence of myocardial infarction [*4,5*] (earlier than the elevation of CPK, especially when a large amount of myoglobin is released [*6*], indicating severe myocardial damage) and quickly regresses.

The present report illustrates the value of the determination of serum myoglobin postmortem in relating cases of sudden death in apparently healthy individuals to acute coronary occlusion.

Materials and Methods

Twenty cases were studied of sudden death with acute coronary occlusion proven by autopsy findings. All cases were dead on arrival at the hospital, most of them in transit. None had received drugs for the purpose of resuscitation but practically all had received some form of cardiac massage.

Peripheral venous blood samples (from femoral, brachial, or subclavian veins) were collected approximately 2, 3, and 4 h after death in some cases and 2 h after death in all others. The blood was collected in a 20-ml plastic syringe attached to a 20-gage needle and promptly transferred to a clean Vacutainer® test tube. After incubation at 37°C in a water bath for 1 h, it was centrifuged at 2000 rpm for 10 min, and then the clear super-

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natant serum was transferred to clean glass test tubes kept at 4°C until used, but no longer than 2 h. Only those samples of serum were used which showed less than 10 mg/100 ml hemoglobin by a standard method [7]. Determined in the sample of serum were the level of LDH [8,9] and its isozyme pattern [10], CPK [11] and its isozyme pattern [12], GOT [13], and myoglobin [4]. The methods for the determination of total LDH, CPK, and GOT of serum were adapted to the Abbott-100 kinetic analyzer. The same studies were carried out in ten individuals who had succumbed to acute accidents such as ruptured aortic aneurysm (two cases), pulmonary embolism (three cases), and subarachnoid and intracerebral hemorrhage (three and two cases, respectively) and who had also received some form of cardiac massage for the purpose of resuscitation.

The autopsy was carried out on the unembalmed cadaver immediately after the collection of the last sample of blood, that is, between 2 and 4 h after death.

Results

The clinical-pathologic details of each case (site of coronary occlusion and its nature) and laboratory results are shown in Table 1. As expected, the occlusion of the anterior interventricular (anterior descending) coronary artery by concentric or ulcerated atheroma was the most common finding.

Elevation of the total enzyme level or abnormal isozyme patterns of CPK and LDH were infrequent in this series. Cases 1, 7, and 15 showed elevation of LDH with "flipped" isozyme pattern and marked elevation of CPK with presence of the hybrid unit MB, which is virtually specific for myocardium. In these cases the level of serum myoglobin was only slightly abnormal, suggesting that these patients had suffered myocardial damage for some time before death. Serial histologic sections stained with hematoxylin and eosin showed moderate eosinophilia with swelling and granularity in the area receiving blood supply through the occluded vessel. These changes suggested hypoxia of the myocardium for some time prior to death. In the remaining 17 cases, LDH and CPK and their isozymes were not significantly abnormal, while the myoglobin level of serum was significantly elevated as compared to the control group. The elevation peaked at 3 h after death and then regressed (Fig. 1). Histologic findings were minimal and inconstant in this group.

Discussion

The purpose of this study was to establish whether the determination of serum myoglobin may be of help in (1) determining the cause of sudden and unexpected death in circumstances where coronary artery disease, coronary occlusion, and cardiac arrest are suspected but no autopsy can be performed for some reason; and (2) validating the findings of coronary occlusion at autopsy. The analysis of the results supplies positive answers to each question.

The analysis of the 20 cases submitted confirms that only seldom was the determination of serum GOT, CPK, and LDH and their isozyme patterns of substantial help in allowing a diagnosis of acute coronary occlusion. However, the level of serum myoglobin showed a constant elevation within 2 h of sudden death resulting from acute coronary occlusion. Apparently a massive release of myoglobin allowed its detection very early after the occurrence of the catastrophe. The possibility that part of the myoglobin recovered in the serum might have originated from damaged muscle remains (that is, trauma to pectoral muscles during attempted resuscitation). It is made somewhat unlikely, however, by the fact that no comparable elevation of serum myoglobin was noted in patients dying suddenly from other causes who also received cardiac resuscitation. The sustained presence of myoglobin can probably be explained by its slow degradation after death, when its rapid renal clearance is no longer operative.

TABLE 1—*Details in 20 cases of sudden and unexpected death resulting from acute coronary arterial occlusion.*[a]

Case	Age	Sex	Location of Occlusion of Artery	Type of Occlusion	LDH, IU	LDH Isozyme Pattern	CPK, IU	CPK-MB	Serum Myoglobin, ng/ml
1	61	m	anterior interventricular	concentric atheroma	141	"flipped"	167	+	141
2	52	m	right main coronary	ulcerative atheroma	156	normal	107	...	242
3	73	m	anterior interventricular	ulcerative atheroma	201	normal	109	...	186
4	65	m	anterior interventricular	concentric atheroma	162	normal	112	...	221
5	72	f	anterior interventricular	ulcerative atheroma	256	normal	109	...	197
6	61	m	right main coronary	subintimal hemorrhage	175	normal	118	...	296
7	57	m	anterior interventricular	ulcerative atheroma	159	"flipped"	192	+	127
8	63	m	left main coronary	crescentic atheroma	266	normal	107	...	169
9	75	m	anterior interventricular	concentric atheroma	148	normal	179	+	188
10	67	m	left circumflex coronary	ulcerative atheroma	179	normal	107	...	239
11	76	f	anterior interventricular	concentric atheroma	189	normal	108	...	194
12	48	m	anterior interventricular	concentric atheroma	186	normal	196	+	247
13	81	m	left main coronary	concentric atheroma	246	normal	111	...	198
14	68	m	right main coronary	crescentic atheroma	207	normal	109	...	329
15	63	m	anterior interventricular	ulcerative atheroma	192	"flipped"	193	+	132
16	68	f	right main coronary	crescentic atheroma	178	normal	86	...	182
17	66	m	anterior interventricular	ulcerative atheroma	155	normal	123	...	190
18	51	m	right marginal	subintimal hemorrhage	177	normal	93	...	314
19	60	f	anterior interventricular	thrombosis	247	normal	106	...	195
20	54	m	right main coronary	ulcerative atheroma	169	normal	126	...	180
Pool[b]	...	...	...	...	172 ± 41	normal	83 ± 27	...	79 ± 14

[a] The biochemical determinations were carried out on blood samples collected 2 h after death.
[b] Pool consisted of sera from ten individuals who had died suddenly (see text).

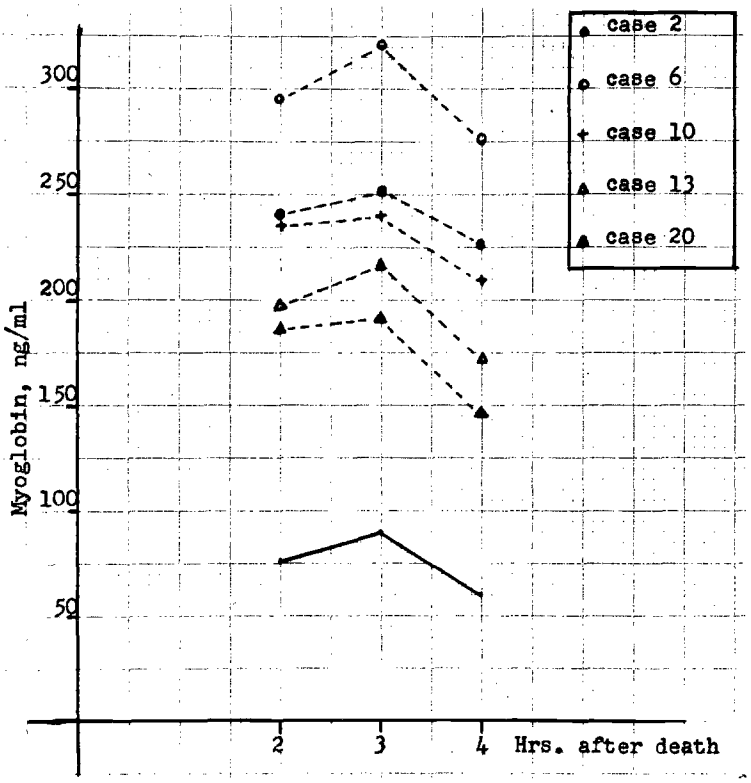

FIG. 1—*Serum myoglobin levels 2, 3, and 4 h after death in five cases of sudden and unexpected death from acute coronary occlusion (Cases 2, 6, 10, 13, and 20 of Table 1) compared to the average (continuous line) of five cases of sudden death from pulmonary embolus (three cases) and acute cerebral vascular accidents (two cases).*

Summary

Serum myoglobin was determined by radioimmunoassay in 20 cases of sudden and unexpected death resulting from acute coronary occlusion. There was consistent elevation of myoglobin 2 h after death, with peaking at 3 h. No comparable elevation of serum myoglobin level was noted in patients who had succumbed to pulmonary embolism, ruptured aortic aneurysm, or subarachnoid or intracerebral hemorrhage. Thus, determination of serum myoglobin seems useful in confirming or establishing acute coronary occlusion as the cause of sudden and unexpected death.

References

[*1*] Fisher, R. S. and Petty, C. S., Eds., *Forensic Pathology: A Handbook for Pathologists,* 027-000-00541-1, U.S. Government Printing Office, Washington, D.C., July 1977, pp. 21-49.

[*2*] Jutzy, R. V., Nevatt, G. W., Palmer, F. J., and Nelson, J. C., "Radioimmunoassay of Serum Myoglobin in Acute Myocardial Infarction," *American Journal of Cardiology,* Vol. 35, No. 1, Jan. 1975, p. 147 (abstract).

[*3*] Biorck, G., "On Myoglobin and Its Occurrence in Man," *Acta Medica Scandinavica,* Vol. 133, Supplement 226, April 1949, pp. 1-216.

[*4*] Stone, M. J., Willerson, J. T., Gomez-Sanchez, C. E., and Waterman, M., "Radioimmunoassay of Myoglobin in Human Serum. Results in Patients with Acute Myocardial Infarction," *Journal of Clinical Investigation,* Vol. 56, No. 5, Nov. 1975, pp. 1334-1339.

[5] Kagen, L. J., Scheidt, S., Roberts, L., Porter, A., and Paul, H., "Myoglobinemia Following Acute Myocardial Infarction," *American Journal of Medicine,* Vol. 58, No. 2, Feb. 1975, pp. 177-182.

[6] Kagen, L. J., Scheidt, S., and Butt, A., "Serum Myoglobin in Myocardial Infarction: the 'Staccato Phenomenon.' Is Acute Myocardial Infarction in Man an Intermittent Event?" *American Journal of Medicine,* Vol. 62, No. 1, Jan. 1977, pp. 86-92.

[7] Ham, T. H., Ed., *A Syllabus of Laboratory Examinations in Clinical Diagnosis,* Harvard University Press, Cambridge, Mass., 1950, p. 152.

[8] Wacker, W. E. C., Ulmer, D. D., and Vallee, B. L., "Metalloenzymes and Myocardial Infarction. II. Malic and Lactic Dehydrogenase Activity and Zinc Concentrations in Serum," *New England Journal of Medicine,* Vol. 255, 6 Sept. 1956, pp. 449-456.

[9] Henry, R. J., Chiamori, N., Golub, O. J., and Berkman, S., "Revised Spectrophotometric Methods for the Determination of Glutamic-Oxaloacetic Transaminase and Lactic Dehydrogenase," *American Journal of Clinical Pathology,* Vol. 34, No. 4, Oct. 1960, pp. 381-398.

[10] Wilkinson, J. H., *Isozymes,* 2nd ed., Lippincott, Philadelphia, 1960.

[11] Oliver, I. T., "A Spectrophotometric Method for the Determination of Creatine Phosphokinase and Myokinase," *Biochemical Journal,* Vol. 61, No. 1, 28 Jan. 1955, pp. 116-122.

[12] Somer, H. and Konttinen, A., "Demonstration of Serum Creatine Kinase Isozymes by Fluorescence Technique," *Clinica Chimica Acta,* Vol. 40, No. 8, Aug. 1972, pp. 133-138.

[13] Karmen, A. J., Wrobleski, F., and LaDue, J. S., "Transaminase Activity in Human Blood," *Journal of Clinical Investigation,* Vol. 34, No. 1, Jan. 1955, pp. 126-133.

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