

Myofiberbreak-up: A marker of ventricular fibrillation in sudden cardiac death

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Abstract

Background: Electrophysiologically, ventricular fibrillation is defined as a “chaotic, random, asynchronous electrical activity of the ventricles due to repetitive re-entrant excitation and/or rapid focal discharge”. To this point its morphological equivalent has not been defined.

Material and method: Several groups of different diseases and types of accidental death in normal subjects were studied. A complete autopsy was performed and the hearts were examined in 432 cases. A total of 16 myocardial samples per heart were processed for histological examination and sections were stained by haematoxylin and eosin or by specific stains. The frequency, location and extent of myocellular segmentation (stretching and/or rupture) of intercalated discs and associated changes of myocardial bundles and single myocells were investigated. A quantitative analysis was performed and the data were processed for statistical evaluation.

Results: The frequency of MFB was maximal in coronary (88%) and Chagas (76%) groups followed by the intracranial brain haemorrhage group (52%). The extent of myofiberbreak-up was maximal in coronary/Chagas groups followed by intracranial haemorrhage and transplant groups.

Conclusions: No correlation was seen between gender, age, heart weight, degree of coronary atherosclerosis, myocardial fibrosis, survival and MFB. If our postulate is correct, finding MFB in the myocardium might allow the diagnosis of a malignant arrhythmia followed by cardiac arrest due to ventricular fibrillation even in the absence of clinical information (sudden death out-of-hospital).

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1. Introduction

Electrophysiologically, ventricular fibrillation is defined as a “chaotic, random, asynchronous electrical activity of the ventricles due to repetitive re-entrant excitation and/or rapid focal discharge” [1]. To this point its morphological equivalent has not been defined.

In a previous study of selected cases of sudden and unexpected death [2], we learned [3] to distinguish the typical contraction band lesion [4] of catecholamine myo-

toxicity from a myocardial change marked histologically by a break-up of myocardial fibers (myofiberbreak-up or MFB) [5].

Fragmentatio miocardii in the old literature [6] meant a linear rupture along the myocardial cell course (fragmentation) or at the disc level (segmentation). A systematic autolysis investigation on the heart was performed by Nicolas [7]. The onset of fragmentation of heart muscle fibers occurred at 12–18 h post-mortem: this finding is easy to recognize in longitudinal cell sections [8]. If fragmentation is likely artifactual [9], however, a relationship between segmentation and contracted myocells was mentioned long ago [6] and related to ventricular fibrillation [10]. A possibility afterwards totally ignored.

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The aims of this report are to a) define the morphology and frequency of this structural break-up; b) exclude the possibility that it is an artefact of rigor mortis, autolysis or histological preparation; c) determine if it has any relationship to either therapy or other forms of myonecrosis; d) discuss its pathophysiology and e) comment on the significance of this change particularly in the forensic pathology setting.

2. Material and method

2.1. Study population

To explore the meaning of MFB several conditions were matched, each with some distinctive points that could aid interpretation. Thus, sudden and unexpected coronary and Chagas's death and that from intracranial haemorrhage all showed a high frequency of focal myocardial necrosis typical of catecholamine myotoxicity. The AIDS group included young individuals who died of opportunistic infectious diseases with a long terminal period and with many types of therapeutic interventions. The end-stage congestive heart failure group represented three main categories of disease, i.e. ischemic heart disease, dilated cardiomyopathy of unknown origin and chronic valvulopathy; its common denominator was cardiac arrest by surgical excision without any further manoeuvres. Transplanted heart group is an example of denervated heart with consequent increased sensitivity of the myocardium to catecholamines [11,12]. The cocaine group was included due to a recognised increased adrenergic activity [13]. The other three groups were selected as healthy people who died of various types of accidents. Thus, hearts from the following groups of people were examined:

1. Coronary group. Twenty-five "healthy" subjects, who had no history of ischemic heart disease, or other cardiac or non-cardiac diseases, died suddenly and unexpectedly out-of-hospital while enjoying their usual lifestyle. Thirteen died within a few minutes

according to witnesses and were found dead. A rescue team made no resuscitation attempts. The other 12 received resuscitation and were monitored by electrocardiogram. In 21 cases pathologic findings other than coronary atherosclerosis, contraction band necrosis (CBN) old foci of myocardial fibrosis and cardiac hypertrophy were not found at autopsy. In four cases CBN was associated with a silent acute infarct with a histological age ranging from 8 h to 7 days. Tests for intoxication and poisoning were negative.

2. Chagas group. Thirty-four apparently healthy subjects who died suddenly and unexpectedly were serum positive for Chagas's disease at autopsy [14]. None had a clinical history of cardiac disease, medical care or therapy, resuscitation attempts, significant post-mortem changes in organs other than heart or a positive test for poisoning or intoxication. According to witnesses the terminal episode lasted a few minutes.
3. Intracranial haemorrhage group. These 27 patients died of a ruptured cerebral berry aneurysm, all without a history of cardiac disease. Thirteen survived less, and 14 more than one day [15].
4. Transplant group. Forty-six patients with irreversible congestive heart failure of various causes who had a heart transplant. The patients subsequently had a survival ranging from less than 1 week to more than 3 years.
5. AIDS group. Thirty-eight cases who had acquired immunodeficiency syndrome and died of non-cardiac opportunistic infectious disease [16].
6. Congestive heart failure (CHF) group. This group included surgically excised hearts at transplantation from 63 patients with chronic ischemic heart disease, 63 with dilated cardiomyopathy of unknown cause and 18 with chronic valvulopathy, all patients being in end-stage congestive heart failure. At surgery none had electrocardiographic arrhythmias [17].
7. Cocaine group. Twenty-six subjects dead from cocaine intoxication, 18 of whom died out-of-hospital without any emergency therapy and eight in hospital [18].

Table 1
Main characteristics of groups

Groups	Cases	Gender		Age (yrs)	Heart weight (g)	Mode of death	Resuscitation	
		M	W				No	Yes
Coronary	25	21	4	61±3	562±25	Sudden unexpected	13	12
Chagas	34	26	8	49±2	464±28	Sudden unexpected	34	0
Intracranial haemorrhage	27	6	21	59±2	427±19	In hospital	0	27
Transplant	46	39	7	49±1.5	419±19	In hospital	0	46
AIDS	38	33	5	31±2	368±11	In hospital	0	38
CHF	144	130	14	47±1	473±10	Hearts excised at surgery*	0	0
Cocaine	26	20	6	35±1	351±10	18 in and 8 out of hospital	8	18
Head trauma	45	37	8	42±3	364±10	Accidental	45	0
Electrocution	21	21	–	36±4	347±9	Accidental	21	0
CO	26	20	6	48±3	375±14	Accidental	26	0

* Hearts excised at transplantation with adjusted heart weight.

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