Procedia of Engineering and Medical Sciences
Volume: 08 | 2023

Impact of Viability, Ischemia, Scar Tissue, and Revascularization on Outcome after Aborted Sudden Death

Xojiyev Botir Baxtiyorovich
Department of Therapy, Bukhara State Medical Institute, Bukhara, Uzbekistan

Annotation: Survivors of aborted sudden death attributable to ventricular arrhythmias in the presence of coronary artery disease are at risk for recurrences. The substrate underlying these arrhythmias is not clear, and therefore the relation between ischemia, viability, scar tissue (and revascularization), and the incidence of ventricular arrhythmias (and survival) was studied over up to 3 years.

Key words: antiarrhythmic therapy, ischemic/viable myocardium, arrhythmia, ventricular arrhythmias.

Relevance. Survivors of cardiac arrest attributable to life-threatening ventricular arrhythmias are at high risk for recurrent arrhythmic events, and managing this patient group is challenging (1,2). Most ventricular arrhythmias are secondary to ischemic heart disease (3,5)

However, the exact trigger for ventricular arrhythmias has been a matter of debate (4,5,6). Ischemia has been recognized as a trigger for ventricular arrhythmias, and studies have demonstrated that revascularization of ischemic territories resulted in a lower inducibility rate of ventricular arrhythmias (4,5,6) Revascularization also resulted in a reduction of sudden-death rate, and revascularization of hibernating myocardium may also increase electrical stability and thereby prevent arrhythmic death (6,7,8) There are presently no studies that have specifically addressed this issue. Still, a significant number of patients remained inducible after revascularization, and a sudden death-rate of 13% in revascularized patients was demonstrated (4,5,9,10,11). Most likely, coexistence of large areas of scar tissue is responsible for triggering ventricular arrhythmias. It is well known that patients with previous infarction and large areas of scar tissue are at higher risk of sudden death, and implantation of a defibrillator may be warranted (11,12,13)

Thus, the relation between ischemia, viability, scar tissue, and revascularization on the one hand and the incidence of ventricular arrhythmias (and sudden death) on the other hand is not clear. Accordingly, we have evaluated the relation between ischemia, viability, scar tissue (evaluated with technetium-99m tetrofosmin single photon emission computed tomography), and revascularization versus recurrent ventricular arrhythmias (and survival) over a follow-up period of a maximum of 3 years.

Key words: scar tissue, death, ventricular arrhythmias, ischemia, arrhythmic death.

Research objective. Determination of risk factors affecting the degree of lethality when coronary intervention through the skin is carried out in the case of arrhythmia observed in patients with myocardial infarction.

Materials and research methods. One hundred fifty-three survivors of sudden death underwent stress-rest perfusion imaging. Patients with ischemic/viable myocardium (n=73) were revascularized if possible. Final antiarrhythmic therapy was based on the outcome of electrophysiological testing or left ventricular ejection fraction (LVEF). Implantation of a defibrillator was performed in 112 (72%) patients. During 3-year follow-up, 15 cardiac deaths occurred and 42 (29%) patients had recurrent ventricular arrhythmias. Patients with events (death or recurrence) exhibited more often a severely depressed LVEF (≤30%), more extensive scar tissue, and less ischemic/viable myocardium on perfusion imaging and less frequently underwent revascularization. Multivariate analysis identified extensive scar tissue and LVEF ≤30% as the only predictors of death/recurrent ventricular arrhythmias.

Research results.A total of 156 survivors (132 men, mean age 63±10 years) of nonfatal cardiac arrest were included in the study. The presenting arrhythmia was VF in 84 (54%) and VT in 72 (46%). Most (143, 92%) had a previous infarction (>2 months before study entrance). At presentation, 8 (5%) had creatine kinase-MB levels that were slightly elevated (maximum, 38 U/L), possibly indicating minimal myocardial damage.

Based on the inclusion criteria, all patients showed significant coronary artery disease on coronary angiography, and they had on average 2.0±0.8 stenosed coronary arteries. The mean LVEF was 40±19%, and 66 (42%) patients had a LVEF ≤30%.

All patients underwent stress-rest perfusion scintigraphy. Jeopardized myocardium was present in 73 (47%) patients, and subsequent revascularization was performed in 44 (60%) patients. Most revascularized patients (27, 61%) underwent coronary artery bypass grafting, whereas the remaining 17 (39%) underwent percutaneous transluminal coronary angioplasty. The decision for revascularization was based on the clinical data, combined with the presence of jeopardized myocardium; 29 (19%) patients with jeopardized myocardium did not undergo revascularization because of comorbidity or poor target vessel quality (not suited for coronary revascularization). Final therapy was based on the outcome of electrophysiological testing or LVEF. Implantation of a defibrillator was performed in 112 (72%) patients. In addition, 21 (13%) patients underwent radiofrequency catheter ablation of VTs, and 81 (52%) patients received antiarrhythmic medication.

During a median follow-up period of 26 months (25th to 75th percentile, 6 to 36 months), 15 (10%) patients died; cardiac death occurred in 11 (7%) patients. The cardiac deaths were sudden cardiac death in 1 patient and death attributable to (ongoing) heart failure in 10 (91%) patients.

The 3-year survival rate was 86%. Recurrences of ventricular arrhythmias occurred in 42 (27%) patients. Most of these recurrences (36, 86%) occurred in patients who underwent ICD implantation. A composite end point was reached in 50 patients (42 recurrences, 8 deaths; ie, 7 patients died after a recurrence). Patients with recurrences had comparable QRS duration compared with patients without recurrences (112±84 versus 106±67 ms, NS).

Findings on SPECT

Segments

In the 156 patients, 2652 segments were analyzed. Of these, 748 exhibited a defect on the stress perfusion images. Ischemia was observed in 174 (23%) segments. Of the remaining 574 segments with a fixed defect, 217 (29%) showed ≥50% tracer uptake and were classified as viable, whereas 357 (48%) had <50% tracer uptake and were classified as scar tissue.

Patients

Of the 156 patients, 111 (71%) exhibited extensive scar tissue, and 73 (47%) had jeopardized myocardium.

Predictors of Death or Recurrences

Baseline characteristics of patients with and without events (death or recurrences) are shown in the Table. Patients with events had a significantly lower LVEF, more frequently had scar tissue, less

frequently had jeopardized myocardium, and less frequently underwent revascularization. Univariable analysis identified these last 4 characteristics as predictors of events. The event curves of patients with and without revascularization are shown in Figure 1. A significantly higher event rate was observed in patients who did not undergo revascularization (53% versus 15%, $P<0.05$).

Baseline Characteristics of Patients With and Without Events				
IQR indicates interquartile range.	**Alive and No Recurrence**	**Death or Recurrence**	**Arrhythmic Death or Recurrence**	***P* Value**
The *P* values concern the comparison between variables in columns 1 and 2.				
No. of patients	106	50	42	
Age, median, y (IQR)	64 (55–71)	67 (61–70)	66 (60–70)	0.28
Male gender, %	85	84	81	0.88
LVEF, median (IQR)	35% (25–55)	30% (25–45)	30% (25–45)	0.020
Revascularization, %	35.9	12.0	12.0	0.002
Extensive scar, %	63.2	88.0	93.0	0.001
Jeopardized myocardium, %	52.8	34.0	31.0	0.028

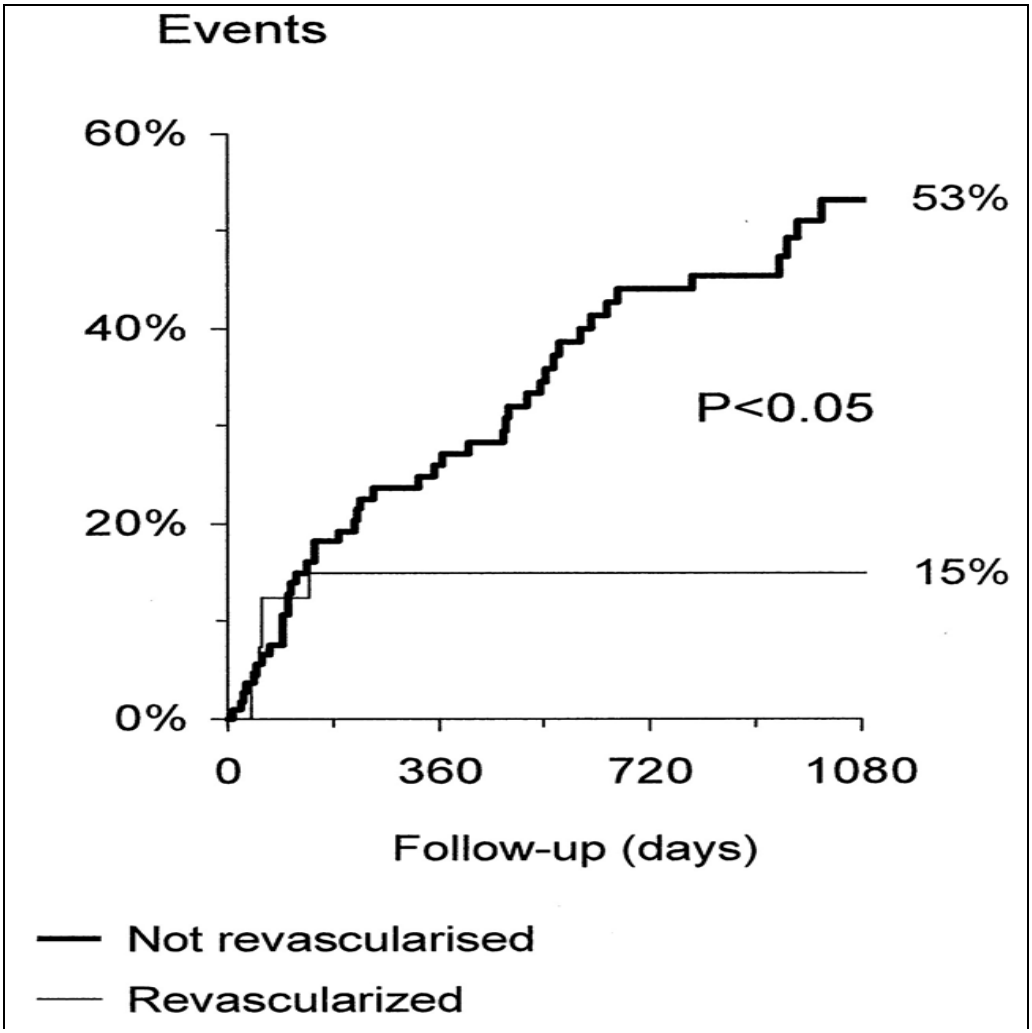

Figure 1. Three-year event curves according to revascularization treatment. Patients who underwent revascularization (n=44) had a significantly lower event rate compared with patients who were treated medically (n=112).

Conclusion— In patients with aborted sudden death, extensive scar tissue and severely depressed LVEF are the only predictors of death or recurrent ventricular arrhythmias. These patients should be considered for implantation of a defibrillator.

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