









Mechanical complications of acute myocardial infarction considering risk factors, treatment and survival of patients in 10-year clinical observation

Mechaniczne powikłania ostrego zawału serca z uwzględnieniem czynników ryzyka, leczenia i przeżywalności chorych w 10-letniej obserwacji klinicznej

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ABSTRACT

INTRODUCTION: Cardiovascular diseases, including coronary disease and its complications, are the most common cause of death. Myocardial infarction is usually caused by a blood clot closing the lumen of a coronary artery at the site of an unstable atherosclerotic plaque.

MATERIAL AND METHODS: All the analyzed patients with mechanical complications of acute myocardial infarction (AMI) were hospitalized at the 2nd Department of Cardiology and Department of Anaesthesiology and Intensive Care of the Upper-Silesian Medical Centre in Katowice in 2006–2016 and the database was based on the medical records of the patients. The study group comprised 52 (100%) patients. There were 23 (44.2%) women and 29 (55.8%) men, aged 54 to 84 years with a mean age of 69.8 years.

RESULTS: Ventricular septal rupture (n = 36; 69.2%) was the most frequently observed complication but papillary muscle rupture (n = 4; 7.7%) and tendinous chord rupture (n = 4; 7.7%) were the least frequent. Hypertension and hypercholesterolemia were the most common risk factors for coronary heart disease in the study group. An increased mortality rate was observed in patients who received pharmacological treatment compared to surgically treated patients (87.5% vs. 61.4%). The majority of patients had one risk factor for coronary heart disease (28; 53.8%).

CONCLUSIONS:

1. In the study group, ventricular septal rupture and the cardiac free wall rupture were the most frequently observed mechanical complications of AMI.
2. Patients with AMI had numerous risk factors for coronary heart disease, of which hypertension and hypercholesterolemia were the most common.

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3. Patients with mechanical complications of AMI had both higher mortality rates than survival and they were higher in the pharmacologically treated group.

KEY WORDS

myocardial infarction, mechanical complications, treatment, survival

STRESZCZENIE

WSTĘP: Choroby układu krążenia, w tym choroba wieńcowa i jej powikłania, stanowią najczęstszą przyczynę zgonów. Zawał mięśnia sercowego spowodowany jest zwykle pęknięciem blaszki miażdżycowej i zamknięciem tętnicy wieńcowej skrzepliną.

MATERIAŁ I METODY: Badaniem objęto 52 chorych (100%) z mechanicznymi powikłaniami ostrego zawału serca, hospitalizowanych w II Oddziale Kardiologii oraz Oddziale Anestezjologii i Intensywnej Terapii Górnośląskiego Centrum Medycznego w Katowicach w latach 2006–2016, w tym 23 kobiety (44,2%) i 29 mężczyzn (55,8%) w wieku 54–84 lat (średnia wieku 69,8 roku).

WYNIKI: Najczęstszym powikłaniem było pęknięcie przegrody międzykomorowej ($n = 36$; 69,2%), natomiast do najrzadszych należały pęknięcie mięśnia brodawkowatego ($n = 4$; 7,7%) i pęknięcie ścięgien ($n = 4$; 7,7%). Nadciśnienie i hipercholesterolemia były najczęstszymi czynnikami ryzyka wystąpienia choroby niedokrwiennej serca w badanej grupie. Zwiększoną śmiertelność zaobserwowano u pacjentów leczonych farmakologicznie (87,5%), podczas gdy śmiertelność pacjentów leczonych operacyjnie wynosiła 61,4%. U większości pacjentów występował jeden czynnik ryzyka choroby wieńcowej ($n = 28$; 53,8%).

WNIOSKI:

1. Najczęstszymi powikłaniami były pęknięcie przegrody międzykomorowej i pęknięcie ściany serca.
2. U pacjentów występowało wiele czynników ryzyka dla choroby niedokrwiennej serca, spośród których najczęstszymi były nadciśnienie i hipercholesterolemia.
3. Śmiertelność w badanej grupie chorych z mechanicznymi powikłaniami ostrego zawału serca znacznie przewyższała przeżywalność i była większa w grupie leczonych zachowawczo.

SŁOWA KLUCZOWE

INTRODUCTION

Mechanism of scar tissue formation and their distant effects

Cardiovascular diseases, including coronary disease and its complications are the most common cause of death. Myocardial infarction is usually caused by a blood clot closing the lumen of a coronary artery at the site of an unstable atherosclerotic plaque which is ruptured by inflammatory and reparative processes.

Atherosclerotic plaque rupture causing the sudden closing of coronary artery lumen lead to ischemia and necrosis of this region. Healing of this region is a multi-stage process, beginning 15–20 minutes after the infarction [1]. The formation of inflammatory infiltration, inflammatory cell migration and cytokine production in response to cardiomyocyte necrosis lasting up to 3 days, is the first stage of the inflammatory process which causes the formation of granular tissue.

In the next stage, the dead cells are removed by the leukocytes from the infarcted region, suppressing the inflammatory response and activating the regenerative cells [2]. The fibrosis process is a consequence of the

activation of fibroblasts, transformation into myofibroblasts and synthesis of collagen types I and III. The formation of a collagen-based matrix is the proliferative phase which prevents the heart wall from rupture. The mentioned stages are the early phase of adaptive cardiac muscle reconstruction, lasting from three days to several weeks after the infarction. Fibrosis can also occur outside the wounded area (interstitial and perivascular) which is a negative process leading to increased mechanical stress and stiffness of the chamber, impairing shrinkage and the electrical functions of the heart [3]. Eventually, the infarct scar is formed approximately several months after infarction. Creating a cross-linked collagen network, proliferative cell deactivation and granular cell apoptosis are the scar maturation phases leading to increased tensile strength and shrinkage of the scar [2,3]. Creating a new collagen network is based on the removal and formation of collagen in the extracellular matrix (ECM). The predominance of collagen degradation can lead to aneurysm formation but its excess can be a substrate for the development of arrhythmias and heart failure [4].

As a consequence of the processes discussed above, left ventricular enlargement, a change in its shape and shrinkage deterioration often occur. The size of the necrosis



area determines heart efficiency and the development of complications – the larger the area of necrosis, the greater the probability of their development.

Factors affecting the occurrence of mechanical complications of AMI

In published scientific works, the authors indicate that the factors affecting the occurrence of mechanical complications of AMI include female gender, advanced age, hypertension, smoking, hypercholesterolemia, diabetes, obesity, alcoholism and previous myocardial infarction. In our investigated group, the occurrence of cardiovascular risk factors was analyzed. The most common risk factors in our study group were hypertension, hypercholesterolemia, smoking, diabetes, obesity and alcohol abuse. In case of the coexistence of multiple risk factors, more frequent complications and worse outcomes of corrective surgery occur [5].

Types of mechanical complications of AMI

The mechanical complications of AMI include cardiac free wall rupture, ventricular septal rupture and mitral regurgitation resulting from tendinous chord or papillary muscle rupture. All of these complications cause sudden deterioration in the clinical condition of the patient, leading to life-threatening conditions such as acute heart failure, pulmonary edema, cardiogenic shock or hypotension.

These complications are associated with severe symptoms and very high mortality rates and require consideration of immediate cardiac surgery. An intra-aortic balloon pump (IABP) is often necessary before surgery. An IABP improves diastolic muscle perfusion and reduces systolic load by creating a therapeutic window for the healing process [6].

Free wall rupture is one of the major complications of myocardial infarction [6]. The incidence of ST-elevation myocardial infarction (STEMI) varies from 0.8% to 6.2%, usually within four days after the infarction [7]. Left ventricular rupture is more common but some cases of right ventricular rupture have been described [8]. We can distinguish two types of complications: subacute and acute. In the first case, there is a slow blood flow into the pericardial cavity. In the second type, there is a rapid rupture of the wall on the border of dead and healthy tissue. In both cases, tamponade, false aneurysm, symptoms of shock and death of the patient may occur [6]. Due to the rapid and unpredictable nature of this complication, it is difficult to monitor and choose the effective treatment, with pericardiocentesis, IABP and cardiac surgery as the most appropriate procedures [9].

Ventricular septal rupture occurs most often between the 3rd and 5th days after the infarction and is more frequent after anterior myocardial infarction [10]. In this case a significant leakage between the left and right ventricles, a rapid increase of symptoms of left and right ventricular failure, cardiogenic shock and escalation of already existing heart disease symptoms are reported [11]. The above symptoms are accompanied by the formation of a new holosystolic murmur over the heart, on the left side of the sternum. In spite of the rapid and complete diagnostics and application of the specific treatment to an individual patient i.e. percutaneous coronary interventions (PCI), coronary artery bypass graft (CABG), a high incidence of death occurs [10,12].

Mitral regurgitation is a common complication of myocardial infarction, resulting from myocardial remodeling, displacement or rupture of the anterior, posterior or septal papillary muscle and tendinous chords that connect the muscle to the valve leaflets, limiting their closure [13]. Papillary muscle rupture affects 0.5–5% of patients with AMI and occurs between the 2nd and 10th day after the infarction. In the majority of inferior wall myocardial infarctions there is a rupture of the anterior papillary muscle which is supported by the posterior descending artery (PDA), and branches of the right and left coronary artery [14]. Acute mitral regurgitation, pulmonary edema and holosystolic murmur over the mitral valve often appear in this case.

Diagnostics of mechanical complications of AMI

Rapid diagnostics and hemodynamic stabilization of the patient and surgical treatment are decisive in the diagnosis of mechanical complications. Echocardiography is a diagnostic gold standard. Please note that the diagnosis should be based on the overall clinical picture [15].

Prevention and treatment of mechanical complications after myocardial infarction

In AMI, preventive procedures are to limit the early infarct zone, reduce pain and maintain proper blood pressure, by applying beta-blockers, nitrates, calcium channel blockers and angiotensin converting enzyme inhibitors (ACEI).

Expansion of the necrotic zone has a huge impact on the occurrence of complications. The larger the area of necrosis, the greater the scar formation, which in turn effects weakening of the wall and the occurrence of lesions.

According to Noguchi et al. [16], the use of beta-blockers as prophylactic and perioperative treatment



significantly reduces cardiac incidents and their complications. Nitrates and beta-blockers affect the rhythm frequency and heart contractility. ACEI maintain normal blood pressure without overloading the cardiovascular system and enable the flow of oxygen-rich blood nourishing the cardiomyocytes as well. Calcium channel antagonists are applied because of their negative inotropic action and coronary vasodilatation. Each of the mentioned mechanisms of action leads to lowering the myocardial oxygen demand and reducing the symptoms of ischemia.

MATERIAL AND METHODS

The aim of the study was to evaluate the occurrence of mechanical complications of AMI, risk factors, methods of treatment and patient survival in 10-year clinical observation.

All the analyzed patients with mechanical complications of AMI were hospitalized at the 2nd Department of Cardiology and Department of Anaesthesiology and Intensive Care of the Upper-Silesian Medical Centre in Katowice in 2006–2016 and the database was based on the medical records of the patients. The prevalence of cardiovascular risk factors and the type of mechanical complications of AMI, echocardiographic results, pharmacological vs. surgical method of treatment and patient survival were analyzed. The study group comprised 52 (100%) patients. There were 23 (44.2%) women and 29 (55.8%) men, aged from 54 to 84 years with a mean age of 69.8 years. The data obtained were collected in a spreadsheet and statistically analyzed using Microsoft Excel.

RESULTS

General characteristics of study group with mechanical complications of AMI

The general characteristics of the studied group are shown in Table I.

Characteristics of studied group with AMI according to type of mechanical complications

The patients' characteristics according to the type of mechanical complications of AMI are presented in Figure 1.

Ventricular septal defect ($n = 36$; 69.2%) was the most frequently observed complication. Both papillary mu-

scle rupture ($n = 4$; 7.7%) and tendinous chord rupture ($n = 4$; 7.7%) were the least frequent in patients with mechanical complications of AMI.

Table I. General characteristics of studied group of patients with mechanical complications of acute myocardial infarction

Tabela I. Charakterystyka ogólna badanej grupy chorych z mechanicznymi powikłaniami ostrego zawału serca

Study group		
Number of patients (n, %)		52; 100%
Sex	women (n, %)	23; 44.2%
	men (n, %)	29; 55.8%
Age in years		54–84
\bar{x}		69.8
\pm SD		8.3

Abbreviations: \bar{x} – arithmetic mean, SD – standard deviation from the mean.

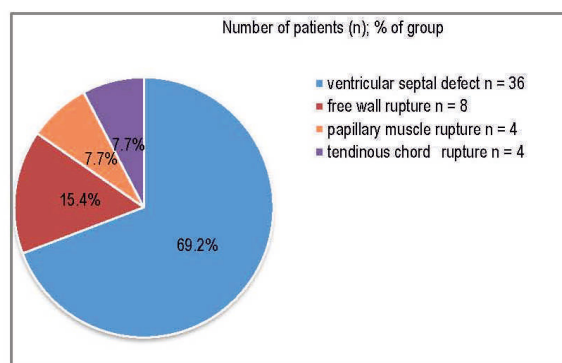


Fig. 1. Characteristics of studied group taking into account type of mechanical complications ($n = 52$; 100%).

Ryc. 1. Charakterystyka badanej grupy uwzględniająca rodzaj powikłań mechanicznych ($n = 52$; 100%).

Characteristics of studied group with AMI according to severity of coronary heart disease and occurrence of risk factors

The characteristics of the study group considering the severity of coronary heart disease are presented in Table II.

The majority of patients with mechanical complications of AMI suffered from single-vessel coronary disease (28; 53.8%). All the patients with multi-vessel coronary disease died (4; 7.7%). The highest survival rate was observed in the group of patients surgically treated with single-vessel disease (12; 27.3%).

The characteristics of studied group with mechanical complications of AMI according to the occurrence of coronary heart disease risk factors are presented in Table III.



Table II. Characteristics of studied group with mechanical complications of acute myocardial infarction according to severity of coronary heart disease as well as survival and treatment

Tabela II. Charakterystyka badanej grupy chorych z mechanicznymi powikłaniami ostrego zawału serca z uwzględnieniem zaawansowania choroby wieńcowej oraz przeżywalność i sposób leczenia

Progression of coronary disease		All patients		Surg.		Pharm.	
		n	%	n	%	n	%
Number of patients – n, %							
	Σ	52	100.0	44	84.6	8	15.4
Number (n) and % of patients investigated	s	18	34.6	17	32.7	1	1.9
	d	34	65.4	27	51.9	7	13.5
	Σ	52	100.0	44	100.0	8	100.0
Number (n) and % of given group	s	18	34.6	17	38.6	1	12.5
	d	34	65.4	27	61.4	7	87.5
	Σ	28	53.8	25	56.8	3	37.5
Single-vessel disease	s	13	25.0	12	27.3	1	12.5
	d	15	28.8	13	29.5	2	25.0
	Σ	20	38.5	17	38.6	3	37.5
Double-vessel disease	s	7	13.5	7	15.9	0	0
	d	13	25.0	10	22.7	3	37.5
	Σ	4	7.7	2	4.6	2	25.0
Multi-vessel disease	s	0	0	0	0.0	0	0
	d	4	7.7	2	4.6	2	25.0

Abbreviations: Surg. – patients treated surgically; Pharm. – patients treated pharmacologically; s – survived; d – died; Σ – summation.

Table III. Characteristics of study group with mechanical complications of acute myocardial infarction according to occurrence of risk factors for coronary heart disease

Tabela III. Charakterystyka badanej grupy z mechanicznymi powikłaniami ostrego zawału serca uwzględniająca występowanie czynników ryzyka choroby wieńcowej

Risk factors for coronary artery disease		All patients		Surg.		Pharm.	
		n	%	n	%	n	%
Number of patients – n, %							
1		2		3		4	
	Σ	52	100.0	44	84.6	8	15.4
Number (n) and % of patients investigated	s	18	34.6	17	32.7	1	1.9
	d	34	65.4	27	51.9	7	13.5
	Σ	52	100.0	44	100.0	8	100.0
Number (n) and % of given group	s	18	34.6	17	38.6	1	12.5
	d	34	65.4	27	61.4	7	87.5
	Σ	26	50.0	20	45.5	6	75.0
Hypertension	s	10	19.2	9	20.5	1	12.5
	d	16	30.8	11	25.0	5	62.5
	Σ	21	40.4	13	29.6	8	100.0
Hypercholesterolemia	s	11	21.2	8	18.2	3	37.5
	d	10	19.2	5	11.4	5	62.5
	Σ	12	23.2	7	15.9	5	62.5
Smoking	s	6	11.6	3	6.8	3	37.5
	d	6	11.6	4	9.1	2	25.0
	Σ	13	25.0	6	13.6	7	87.5
Diabetes	s	5	9.6	3	6.8	2	25
	d	8	15.4	3	6.8	5	62.5



	1	2		3		4		
		Σ	5	9.6	3	6.8	2	25.0
Obesity		s	0	0	0	0	0	0
		d	5	9.6	3	6.8	2	25.0
		Σ	2	3.8	2	4.6	0	0
Alcohol abuse		s	0	0	0	0	0	0
		d	2	3.8	2	4.6	0	0

Abbreviations: Surg. – patients treated surgically; Pharm. – patients treated pharmacologically; s – survived; d – died; Σ – summation.

Hypertension and hypercholesterolemia were the most common risk factors for coronary heart disease in the study group. An increased mortality rate was observed in patients pharmacologically treated compared to surgically treated patients (87.5% vs. 61.4%).

Characteristics of study group with AMI according to occurrence of coronary heart disease risk factors, type of mechanical complications of AMI, their treatment and survival

The characteristics of the studied group with mechanical complications of AMI according to the number of risk factors for coronary heart disease, and survival are presented in Figure 2.

The majority of patients had one risk factor for coronary heart disease (28; 53.8%). With an increase in the

number of coronary heart disease risk factors, the mortality rate consequently rose.

The patients' characteristics with mechanical complications of AMI based on survival are presented in Figure 3. Attention is drawn to the high mortality rate of patients with mechanical complications of AMI (34; 65.4%). The highest mortality rate was observed in patients with tendinous chord rupture (4; 100%), while the greatest survival rate in patients with papillary muscle rupture (3; 75%) was observed.

The characteristics of the studied group with mechanical complications of AMI according to the treatment method and survival are presented in Table IV.

Most of the patients were treated surgically (44; 84.6%), while a higher mortality rate was observed in the patients treated pharmacologically (87.5% vs. 61.4%).

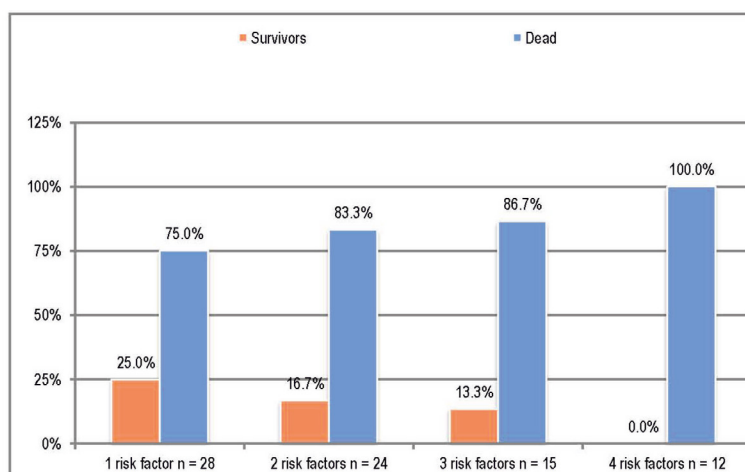


Fig. 2. Characteristics of studied group taking into account number of risk factors for coronary heart disease, and survival (n = 52; 100%).

Ryc. 2. Charakterystyka badanej grupy chorych z uwzględnieniem liczby czynników ryzyka choroby wieńcowej i przeżywalności (n = 52; 100%).

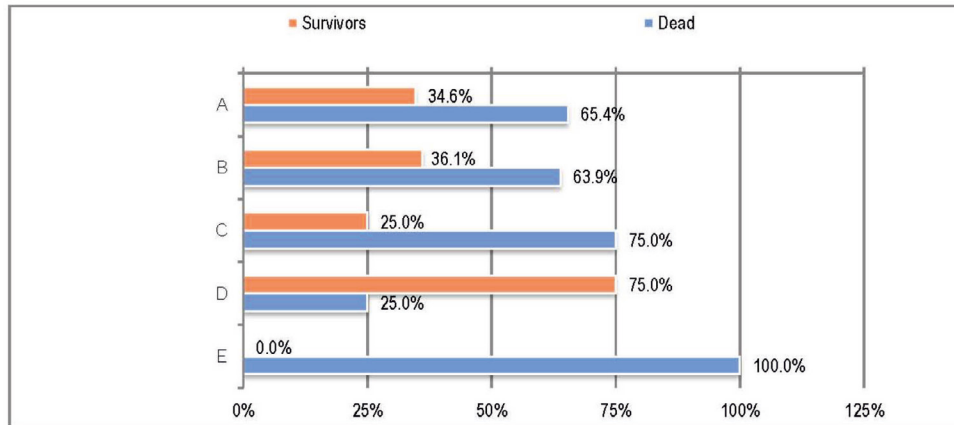


Fig. 3. Characteristics of studied group taking into account type of mechanical complications of acute myocardial infarction, and survival (n = 52; 100%); A – all patients (n = 52); B – ventricular septal defect (n = 36); C – free wall rupture (n = 8); D – papillary muscle rupture (n = 4); E – tendinous chord rupture (n = 4).

Ryc. 3. Charakterystyka badanej grupy chorych uwzględniająca rodzaj mechanicznego powikłania ostrego zawału serca i przeżywalność (n = 52; 100%).

Table IV. Characteristics of studied group with mechanical complications of acute myocardial infarction including treatment method and survival

Tabela IV. Charakterystyka badanej grupy z mechanicznymi powikłaniami ostrego zawału serca uwzględniająca sposób leczenia i przeżywalność

Mechanical complications of acute myocardial infarction		All patients		Surg.		Pharm.	
		n	%	n	%	n	%
Number of patients – n, %	Σ	52	100.0	44	84.6	8	15.4
Number (n) and % of patients investigated	s	18	34.6	17	32.7	1	1.9
	d	34	65.4	27	51.9	7	13.5
	Σ	52	100.0	44	100.0	8	100.0
Number (n) and % of given group	s	18	34.6	17	38.6	1	12.5
	d	34	65.4	27	61.4	7	87.5
	Σ	36	69.2	32	72.7	4	50.0
Ventricular septal defect	s	13	25.0	12	27.3	1	12.5
	d	23	44.2	20	45.4	3	37.5
	Σ	8	15.4	5	11.4	3	37.5
Free wall rupture	s	2	3.8	2	4.6	0	0
	d	6	11.6	3	6.8	3	37.5
	Σ	4	7.7	3	6.8	1	12.5
Papillary muscle rupture	s	3	5.8	3	6.8	0	0
	d	1	1.9	0	0	1	12.5
	Σ	4	7.7	4	9.1	0	0
Tendinous chord rupture	s	0	0	0	0.0	0	0
	d	4	7.7	4	9.1	0	0
	Σ	4	7.7	4	9.1	0	0

Abbreviations: Surg. – patients treated surgically; Pharm. – patients treated pharmacologically; s – survived; d – died; Σ – summation.



DISCUSSION

The presented work is based on the data collected from 52 patients hospitalized at the 2nd Department of Cardiology and Department of Anaesthesiology and Intensive Care of the Upper-Silesian Medical Centre in Katowice in 2006–2016. The purpose of the study was to evaluate the occurrence of mechanical complications of AMI, coronary heart disease risk factors, their treatment and survival. The analyzed group comprised a total of 52 (100%) patients, among whom 23 (44.2%) were women and 29 (55.8%) men with a mean age of 69.8 years.

Occurrence of mechanical complications of AMI

The data collected in the study are consistent with previously published reports.

The study showed that the most common mechanical complication of AMI was ventricular septal rupture ($n = 36$; 69.2%) with a mortality rate of 63.9%. Both papillary muscle rupture ($n = 4$; 7.7%) and tendinous chord rupture ($n = 4$; 7.7%) were the least common complications. Similar results were obtained by Ashfaq and Sharif [17], but their mortality rate of patients with ventricular septal defect was 10%. This may be due to the fact that fewer ($n = 10$; 56%) and younger (61.78 ± 10.58) patients were analyzed in their study. Unfortunately, most of the published studies focused on only one mechanical complication, which made it difficult to compare the obtained data.

Occurrence of patients' risk factors for mechanical complications of AMI

The analysis showed that the most common risk factors among all the patients with mechanical complications were: hypertension ($n = 26$; 50%), hypercholesterolemia ($n = 21$; 40.4%) and smoking ($n = 12$; 23.2%). A higher mortality rate in pharmacologically treated patients comparing to surgically treated ones (87.5% vs. 61.4%) was observed. Tang et al. [18] and Yalcinkaya et al. [19] also revealed a similar incidence of risk factors. On the other hand, other studies showed that in addition to hypertension, the incidence of diabetes was often as high as 44.7% and in another study 65.5% [20,21]. With reference to the group we analyzed (13; 25%), their results are very high. This may be due to the fact that the patients included in their study came from another continent where other dietary habits and prophylaxis for this disease exist. The risk factors such as older age, female gender and prolonged time from myocardial infarction to onset of treatment are listed as

independent factors of mechanical complications, particularly free wall rupture [22]. Considering the female gender as a risk factor is controversial among many authors. However, this can be explained by the older age of the investigated women comparing to men and the presence of other gender-related risk factors [9].

Wożakowska-Kapłon et al. [23] presented other observations that female gender, older age, a brief medical history and no prior symptoms of angina are risk factors for mechanical complications of AMI. The protection factors include male gender, smoking, multi-vessel disease, previous stroke or angina pectoris and other non-hypertensive risk factors for vascular disease. The lower incidence of cardiac rupture in these states was explained by the ischemic preconditioning (IPC) phenomenon and the production of collateral circulation.

The relationship between the occurrence of myocardial infarction complications and hypertension has always been controversial. Nozoe et al. [24] noted that the lack of hypertension is a risk factor for complications because of the absence of thickened ventricular walls due to long-term hypertension. In multivariate analysis – elder age, single-vessel coronary artery disease, lack of hypertension and prior PCI were the risk factors associated with the mechanical complications of AMI. Similar correlations were noted by Cinq-Mars et al. [5]. Low diastolic blood pressure was identified as a significant mortality factor during and after surgical treatment of mechanical complications of AMI. It has been shown that a decreasing diastolic blood pressure below 60 mmHg leads to higher mortality rate, despite radical treatment efforts. This is due to the development of cardiogenic shock. In turn, Pang et al. [25] identified the development of cardiogenic shock as the most important predictor of mortality, because not performing surgical treatment results in death of the patient. In contrast, our research has shown that elevated blood pressure is a factor that increases the incidence of complications of AMI. Among all the patients, half of them ($n = 26$; 50%) had hypertension and also a higher mortality rate was observed in this group of patients (survived – $n = 10$; 19.2%, died – $n = 16$; 30.8%).

Huang et al. [20] have focused particular attention on the occurrence of risk factors taking into account the survival and progression of coronary heart disease in the patients studied. The highest mortality rate was seen in patients with multi-vessel coronary artery disease based on a population of 47 people with ventricular septal defect. It should be noted that most of the patients they studied had advanced coronary artery disease. Serpytis et al. [21] demonstrated that the largest group of patients was people with single-vessel coronary artery disease. Nozoe et al. [24] suggested that single-vessel disease is the most important factor leading to complications.



The authors of another publication who compared the survival rate of patients with single and double-vessel coronary artery disease (22 patients in group 1) and patients with multi-vessel coronary artery disease (6 patients in group 2) had comparable results to those in our publication i.e. 28 patients (53.8%) with single-vessel disease (survived 13; 25%, died 15; 28.8%), 20 patients (38.5%) with double-vessel disease (survived 7; 13.5%, died 13; 25%) and 4 patients (7.7%) with multi-vessel disease (4 died; 7.7%). In their 10-year follow-up, the survival rate in Group 1 (50.7%) was significantly higher than in Group 2 (25%) [16]. Our analyses are consistent with the results of the cited researchers. The majority of patients had single-vessel coronary artery disease and the highest mortality rate was also seen in patients with multi-vessel coronary artery disease. This may be due to the fact that the larger the part of coronary arteries occupied, the greater the area of ischemia is and consequently greater bleeding and hemodynamic disturbances occur. It is interesting that there was also a positive correlation between the number of risk factors for coronary heart disease and mortality but the majority of patients had only one risk factor for coronary heart disease. For comparison, having one risk factor, the patient mortality rate was 75% and with 3 and 4 risk factors the patient mortality rates were 86.7% and 100%, respectively.

Treatment method and survival of patients with mechanical complications of AMI

Mechanical complications of AMI represent a serious clinical problem. This is due to their effect on sudden deterioration of the patient's health, quality of life and high mortality rates. It is therefore extremely important to make quick diagnostics and decisions on the right course of treatment.

In a randomized study conducted at the Mayo Clinic, it was concluded that echocardiography should be performed as soon as possible, followed by coronarography and rapid surgical intervention. Their studies highlight the unpredictable course and significant mortality of patients with such complications. According to the study, the mortality rate was about 20 to 25% during the treatment of papillary muscle rupture and the long-term outcome after surgery showed excellent survival. In contrast, the mortality rate of those who were not surgically treated was high. However, in our study 3 (6.8%) patients with papillary muscle rupture ($n = 4$; 7.7%) were treated surgically and 1 (12.5%) pharmacologically. All the patients treated surgically survived (3; 6.8%) but the patient treated pharmacologically died (1; 12.5%). It is worth noting that patients with this complication have the highest survival rate (75%). Mayo

Clinic studies have also shown that from patients who underwent ventricular septal rupture and cardiogenic shock, only those who underwent surgical treatment within 48 hours survived. The number of patients in this group was only 38. The clinical course of patients without cardiogenic shock was unpredictable with the possibility of rapid deterioration of health and death in approximately 50% of cases [26].

Heiberg et al. [27] compared the groups of patients with ventricular septal rupture treated pharmacologically, surgically and percutaneously. It was found that percutaneous closure was associated with a lower mortality rate than surgical and pharmacological treatment. The surgically treated patients' mortality rate was 69% ($n = 28$) while the pharmacologically treated patients' mortality rate was 91.7% ($n = 12$) in a 5-year follow-up. Some interesting observations were that the surgically treated patients were slightly younger, had a higher ejection fraction and a lower incidence of coexisting diseases, while the group treated percutaneously had a smaller mean rupture diameter.

Similar findings were obtained by Sathananthan and Ruygrok [28]. The study highlighted the percutaneous closure as a viable alternative to surgical treatment. The long-term survival curves of patients treated with both methods (percutaneous and surgical) showed that 75% of those surgically treated died but only 44% after percutaneous closure. The most likely explanation for the mentioned difference was the other treatment strategy for each patient, dictated by the clinical symptoms.

Radosavljević-Radovanović et al. [29] found that despite improved treatment, surgical technique and percutaneous revascularization, the mortality rate ranged from 24% to 87%. The patients treated pharmacologically showed an even greater mortality rate – 90%.

The quoted results are compatible with ours. The mortality rate of patients with ventricular septal rupture treated surgically was 45.4% ($n = 20$) and treated pharmacologically 37.5% ($n = 3$). The lower mortality rate of patients treated pharmacologically may be due to the difference in the number of untreated patients and to the reference level of the centers. Other studied mechanical complications of AMI are free wall rupture and tendinous chord rupture. Most patients with cardiac free wall rupture ($n = 8$; 15.4%) were treated surgically ($n = 5$; 11.4%) and the mortality rate was high ($n = 6$; 75%). However, the highest mortality rate was seen in the group of patients with tendinous chord rupture ($n = 4$; 100%) who only underwent surgical treatment.

In addition to the above-mentioned studies, there are numerous descriptions of individual cases of mechanical complications of AMI but they do not include a full assessment of the factors we took under consideration. They focus on describing selected mechanical compli-



cations and the treatment used, emphasizing the advantage of surgical treatment [30,31].

CONCLUSIONS

1. In the study group, ventricular septal rupture and the cardiac free wall rupture were the most frequently observed mechanical complications of AMI.

2. Patients with AMI had numerous risk factors for coronary heart disease, of which hypertension and hypercholesterolemia were the most common.

3. Patients with mechanical complications of AMI had both higher mortality rates than survival rates and they were higher in the pharmacologically treated group.

Author's contribution

Study design – J. Dąbek

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Data interpretation – J. Dąbek, Z. Gąsior

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