ORIGINAL ARTICLE

Factors affecting short- and long-term survival of patients with acute coronary syndrome treated invasively using intravascular ultrasound and fractional flow reserve: Analysis of data from the Polish Registry of Acute Coronary Syndromes 2017–2020

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ABSTRACT

Background: Intravascular ultrasound (IVUS) and fractional flow reserve (FFR) are invasive procedures increasingly used in treating acute coronary syndrome (ACS).

Aims: This study aimed to evaluate the frequency of IVUS and FFR use in patients with ACS in Poland and to assess the safety of these procedures as well as their impact on short- and long-term survival.

Methods and results: This retrospective study included 103849 patients enrolled in the Polish Registry of Acute Coronary Syndromes in 2017–2020. IVUS was performed in 1727 patients, FFR in 1537 patients, and both procedures in 37 patients. The frequency of performing FFR in ACS patients increased over the years from 1.3% to 1.8% (P <0.0001) and IVUS from 1.7% to 2.3% (P <0.0001). In the FFR and/or IVUS group, a similar incidence of stroke, reinfarction, target vessel revascularization, and major bleeding was observed while in-hospital mortality was lower (0% for IVUS + FFR vs. 0.9% for FFR vs. 2.3% for IVUS vs. 3.7 for no procedure; P <0.0001). FFR and IVUS did not affect the 30-day and one-year prognosis.

Conclusion: In recent years, the number of FFR and IVUS procedures performed in patients with ACS in Poland has increased. There was lower in-hospital mortality in the FFR and/or IVUS group in ACS patients, and no differences in the incidence of stroke, reinfarction, target vessel revascularization, and major bleeding were observed. Performing FFR and IVUS in ACS patients does not significantly affect 30-day or one-year mortality.

Key words: acute coronary syndrome, coronary artery disease, fractional flow reserve, intravascular ultrasound

INTRODUCTION

In recent years, cardiovascular diseases have become a major cause of death in developed countries [1]. To gain a better understanding of the nature of the disease and to optimize diagnosis and therapy in sudden cardiac events, many countries have established large medical registries for data collection. In Poland, the reference registry collecting data on sudden cardiac events is the Polish Registry of Acute Coronary Syndromes (PL-ACS) [2]. Analysis of registry data provides information on many factors associated with the prognosis of acute coronary syndrome (ACS) [3, 4]. One of the less well-known and studied factors is the use of intravascular ultrasound (IVUS) and fractional flow reserve (FFR) in the diagnosis of ACS [5].

WHAT'S NEW?

We present current trends in the use of intravascular ultrasound (IVUS) and fractional flow reserve (FFR) in the treatment of acute coronary syndromes based on the Polish Registry of Acute Coronary Syndromes. Their frequency of use is increasing, and they are also safe. However, although they reduce in-hospital mortality, they do not affect 30-day and annual survival.

An intravascular probe was used to evaluate coronary artery lesions for the first time in 1980 [6]. Since then, the use of this technique has become widespread. This method allows real-time assessment of the vessel lumen and morphology and volume of the atherosclerotic plaque, as well as optimization of stent deployment [7]. IVUS is also used in diagnostically ambiguous clinical cases such as suspected intramural hematoma or double vessel lumen [8].

FFR is an index that determines the degree of coronary stenosis, defined as the ratio of maximal blood flow in the zone of stenosis to normal maximal flow [9]. The main indication for use of this technique in diagnosis is examination of patients with multivessel disease or moderate-degree stenosis (40%–90%) if no ischemia is found on non-invasive testing [10]. Based on numerous clinical studies, the acceptable threshold value considered to be hemodynamically significant is 0.80 [11, 12]. In patients with stable coronary artery disease and an FFR of 0.80 or lower, percutaneous coronary intervention (PCI) with drug-eluting stent implantation was shown to result in reduced incidence of the primary endpoint of death, non-fatal myocardial infarction, and urgent revascularization at 2 years, compared with conservative treatment [13]. Both IVUS and FFR are, therefore, good invasive diagnostic tools to evaluate ambiguous coronary lesions and guide appropriate management [10].

This study aimed to evaluate the frequency of IVUS and FFR use in patients with ACS in Poland and to assess the safety of these procedures, as well as their impact on short- and long-term survival.

METHODS

Data for 103 849 patients included in the PL-ACS between 2017 and 2020 were analyzed. During that period, the FFR procedure was performed in 1727 patients and IVUS in 1537 patients. We assessed the frequency of IVUS and FFR use in individual centers in Poland based on the number of procedures reported and compared the frequency of IVUS and FFR procedures performed in consecutive years. We analyzed the frequency of complications in groups undergoing IVUS and FFR as well as in patients who did not undergo either of these procedures. Factors associated with achieving 30-day and 1-year survival were determined. The 30-day and 1-year survival rates were compared between patients who underwent IVUS and/or FFR and those who underwent neither of these procedures.

Follow-up data for all-cause mortality were obtained from the National Health Fund database. Follow-up time was censored at 365 days or at the end of follow-up time, on the December 24, 2021 (whichever came first).

Statistical analysis

Categorical variables were shown as numbers of patients and percentages. Continuous variables were not distributed normally, which was verified using the Shapiro-Wilk test, and they were, therefore, presented as median and interquartile range (IQR). Comparisons of categorical and continuous variables across groups were performed using the χ^2 and Kruskal-Wallis tests. Cumulative survival in the groups of patients stratified by the use of IVUS or FFR was presented using Kaplan-Meier curves and compared by the log-rank test. Univariate logistic regression analysis was used to identify variables associated with 30-day mortality and univariate Cox regression analysis was used to identify variables associated with 1-year mortality. Variables that were significantly associated with the outcome in the univariate models were included in multivariable analysis. Statistical significance was defined as P <0.05 (two-tailed). Statistica version 13.3 (TIBCO Software, Palo Alto, CA, US) and MedCalc® Statistical Software version 20.115 (MedCalc Software Ltd, Ostend, Belgium) were used for computational analyses.

RESULTS

Among the 103 849 patients with ACS included in the study, 1727 patients underwent IVUS, 1537 underwent FFR, and 37 had both procedures. Patients' follow-up was presented in Figure 1. Flowchart percentages for deaths and survival refer to the number of patients with available follow-up data. Survival data were not available for only 25 patients without IVUS/FFR and one patient in the IVUS group. Multiple clinical and procedural factors were analyzed. The descriptive characteristics of the study groups are shown in Table 1. In 2017–2020, an increase in the frequency of FFR procedures from 113 (1.3%) to 441 (1.8%) and IVUS from 89 (1.0%) to 557 (2.3%) was observed. In 2020, an increase in 30-day (1489; 6.2%) and 1-year (3292; 13.6%) mortality was observed. Additional information on the laboratory and clinical parameters is shown in Table 2. Annual trends in the number of procedures performed are shown in Figure 2.

The lead center performed FFR in 14.71% of patients with ACS, while IVUS in the lead center was performed in 37.33% of patients with ACS. *Tables S1* and *S2* show the centers in Poland that most frequently performed FFR and IVUS in patients with ACS.

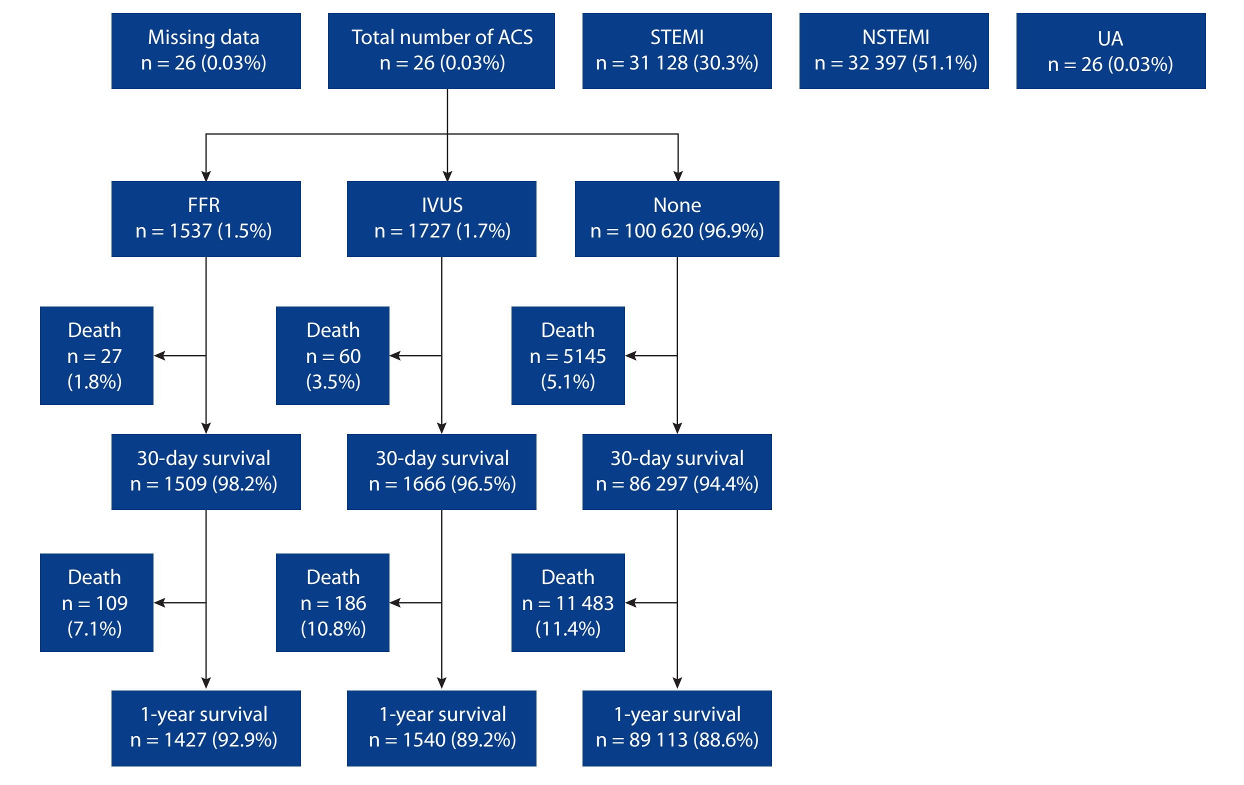

Figure 1. Prognosis of patients included in the PL-ACS registry in 2017–2020

Abbreviations: ACS, acute coronary syndrome; FFR, fractional flow reserve; IVUS, intravascular ultrasonography; NSTEMI, non-ST-segment elevation myocardial infarction; STEMI, ST-segment elevation myocardial infarction; UA, unstable angina

A significant reduction in in-hospital mortality was observed in the group treated with FFR and/or IVUS, other complications occurred with a similar frequency. A comparison of the number of complications depending on the procedures performed (IVUS, FFR, or both) was presented in Table 3.

FFR was more often performed in the left anterior descending artery (LAD), diagonal branch (Dg), and circumference branch (Cx) while IVUS in the left main coronary artery (LM) and obtuse marginal branch (OM). Differences in the use of these procedures depending on ACS presentation and coronary artery typology are shown in Table 4.

The long-term follow-up median (interquartile range [IQR], 365 [365–365] days; mean 335 days) was available for 99.98% of patients. Performing FFR was significantly associated with 30-day and 1-year survival, but only in univariate analysis. Multivariable regression analysis showed no association between FFR or IVUS and 30-day mortality. Logistic regression analysis demonstrated multiple factors significantly associated with 30-day survival in patients with ST-segment elevation myocardial infarction (STEMI) and non-ST-segment elevation myocardial infarction (NSTEMI) (Supplementary materials, *Tables S3–S5*). Factors associated with 1-year survival were shown in Supplementary materials, *Tables S6–S8*.

To compare survival of patients with STEMI, NSTEMI, and unstable angina undergoing FFR and IVUS, Kaplan-Meier curves assessing 1-year survival were plotted (Figure 3A–C). Survival probability was higher in patients with STEMI undergoing FFR.

DISCUSSION

The PL-ACS collects numerous data on the treatment and diagnosis of ACS in Poland. The volume and quality of information collected are so comprehensive that they can successfully compete with similar large European registries, such as the MINAP registry in the UK and the RIKS-HIA registry in Sweden [12, 14]. In addition to traditional coronary angiography, many complementary diagnostic methods are now available for the diagnosis of ACS. IVUS and FFR have become common complementary methods in current diagnostics.

Reports from European cardiological societies show that both diagnostic methods are highly prevalent and available in Europe. In an analysis of 118 706 PCI cases in Portugal, Guerreiro et al. [15] found that IVUS was used in 2266 (1.9%). Moreover, they found increasing use of the method over time: from 0.1% in 2003 to 2.4% in 2006. Similar data showing the increasing use of invasive diagnostic tests over time were found in a large Spanish registry [16]. Other articles have compared IVUS to other modern methods complementary to invasive diagnostics, such as optical coherence tomography [17]. Analysis of data from other large national registries, such as PRIME-FFR (Insights

Table 1. Descriptive characteristics of patients included in the PL-ACS in 2017–2020

Variables	Total (n = 103 849)	2017 (n = 8756)	2018 (n = 35 180)	2019 (n = 35 718)	2020 (n = 24 195)	*P*-value
Male sex, n (%)	67 553 (65.1)	5555 (63.5)	22827 (64.9)	23298 (65.2)	15873 (65.6)	0.003
Age, years, median (IQR)	67.6 (60.6–75.1)	67.9 (61.0–76.1)	67.5 (60.6–75.3)	67.6 (60.6–75.1)	67.7 (60.6–74.5)	0.01
BMI, kg/m², median (IQR)	27.8 (25.1–31.2)	27.7 (25.0–31.0)	27.8 (25.0–31.2)	27.8 (25.0–31.2)	27.9 (25.3–31.2)	<0.001
Acute coronary syndrome						
STEMI, n (%)	31 128 (30.3)	2479 (29.0)	10423 (29.9)	10668 (30.2)	7558 (31.7)	<0.001
NSTEMI, n (%)	52 397 (51.1)	4090 (47.8)	17342 (49.8)	18510 (52.4)	12455 (52.2)	
UA, n (%)	19 045 (18.6)	1979 (23.2)	7064 (20.3)	6170 (17.5)	3832 (16.1)	
Killip classification						
I, n (%)	86 101 (84.3)	7364 (86.5)	29523 (85.1)	29506 (84.1)	19708 (82.9)	<0.001
II, n (%)	11 591 (11.4)	792 (9.3)	3773 (10.9)	4110 (11.7)	2916 (12.3)	
III, n (%)	2 139 (2.1)	166 (2.0)	659 (1.9)	744 (2.1)	570 (2.4)	
IV, n (%)	2 252 (2.2)	188 (2.2)	740 (2.1)	739 (2.1)	585 (2.5)	
CA before admission, n (%)	2 536 (2.5)	228 (2.7)	837 (2.4)	824 (2.4)	647 (2.7)	0.02
Previous MI, n (%)	23 211 (23.9)	2090 (25.5)	8029 (24.1)	7802 (23.5)	5290 (23.8)	0.001
Previous PCI, n (%)	22 762 (23.5)	2021 (24.7)	7846 (23.5)	7689 (23.1)	5206 (23.4)	0.03
Previous CABG, n (%)	5 264 (5.4)	545 (6.6)	1834 (5.5)	1676 (5.0)	1209 (5.4)	<0.001
Previous stroke, n (%)	5 238 (5.4)	487 (6.0)	1776 (5.4)	1777 (5.4)	1198 (5.4)	0.16
PAD, n (%)	6 267 (6.6)	554 (6.9)	2138 (6.5)	2204 (6.7)	1371 (6.3)	0.09
CKD, n (%)	7 696 (8.0)	775 (9.5)	2628 (7.9)	2611 (7.9)	1682 (7.6)	<0.001
COPD, n (%)	4 928 (5.1)	458 (5.7)	1739 (5.3)	1679 (5.1)	1052 (4.8)	0.01
Diabetes, n (%)	26 970 (28.0)	2371 (29.3)	9263 (28.0)	9252 (27.9)	6084 (27.5)	0.03
EF, %, median (IQR)	50 (40–55)	50 (41–55)	50 (42–55)	50 (40–55)	50 (40–55)	<0.001
LM disease, n (%)	6 501 (6.3)	547 (6.3)	2254 (6.4)	2217 (6.3)	1483 (6.2)	0.54
Multivessel disease						
2VD, n (%)	20 575 (19.9)	1612 (18.5)	6984 (19.9)	7116 (20.1)	4863 (20.2)	0.003
3VD, n (%)	8 738 (8.5)	806 (9.2)	2908 (8.3)	3035 (8.6)	1989 (8.3)	
Vascular access						
Radial, n (%)	86 290 (83.9)	6518 (75.9)	28439 (81.4)	30358 (85.9)	20975 (87.3)	<0.001
Femoral, n (%)	15 500 (15.1)	2000 (23.3)	6161 (17.6)	4606 (13.0)	2733 (11.4)	
Other, n (%)	1 057 (1.0)	66 (0.8)	319 (0.9)	366 (1.0)	306 (1.3)	
PCI, n (%)	81 017 (78.6)	6494 (75.5)	27348 (78.2)	27827 (78.4)	19348 (80.3)	<0.001
CABG, n (%)	4 158 (4.1)	441 (5.2)	1508 (4.4)	1340 (3.8)	869 (3.6)	<0.001
30-day mortality rate, n (%)	5231 (5.0)	403 (4.6)	1628 (4.6)	1711 (4.8)	1489 (6.2)	<0.001
1-year mortality rate, n (%)	11775 (11.3)	965 (11.0)	3661 (10.4)	3857 (10.8)	3292 (13.6)	<0.001
FFR, n (%)	1 537 (1.5)	113 (1.3)	394 (1.1)	589 (1.6)	441 (1.8)	<0.001
IVUS, n (%)	1 727 (1.7)	89 (1.0)	427 (1.2)	654 (1.8)	557 (2.3)	<0.001

Categorical data are presented as number of patients (%). Continuous variables are shown as median (interquartile range [IQR])

Abbreviations: 2VD, two vessels disease; 3VD, three vessels disease; BMI, body mass index; CA, cardiac arrest; CABG, coronary artery bypass grafting; CKD, chronic kidney disease; COPD, chronic obstructive pulmonary disease; EF, ejection fraction; FFR, fractional flow reserve; IVUS, intravascular ultrasonography; LM, left main coronary artery; MI, myocardial infarction; NSTEMI, non-ST-segment elevation myocardial infarction; PAD, peripheral artery disease; PCI, percutaneous coronary intervention; STEMI, ST-segment elevation myocardial infarction; UA, unstable angina

from the POST-IT [Portuguese Study on the Evaluation of FFR-Guided Treatment of Coronary Disease] and R3F [French FFR Registry] Integrated Multicenter Registries — Implementation of FFR [Fractional Flow Reserve] in Routine Practice), shows that the frequency of FFR procedures has also been increasing in Europe in recent years [18]. In our study, based on the analysis of PL-ACS data, we found increasing use of this method over time and high involvement of centers performing the procedures.

The use of FFR as a complementary diagnostic method for coronary vascular testing in ACS patients does not seem very promising to date. Patients with ACS and postponed revascularization based on FFR have poorer clinical outcomes than even those with stable angina [19–21]. In the FAMOUS-NSTEMI study, Layland et al. analyzed FFR-guided (n = 176) and angiography-guided (n = 174) groups and showed a significantly lower survival rate in the FFR group [22]. Similarly, in an analysis of the randomized FAME (Fractional flow reserve versus Angiography or Multivessel Evaluation) study, Sels et al. compared FFR-guided PCI in multivessel disease in 1005 patients with either stable or unstable angina. At 2-year follow-up, the two groups did not differ in the rate of major adverse cardiovascular events (MACE) [23]. Similarly, in pooled data from the R3F and POST-IT prospective registry studies, van Belle et al. did not find statistically significant differences between the FFR and conventionally treated groups in a total of 1983 patients at 1-year follow-up [18]. Lee et al. [20] analyzed combined data for 1596 patients from the Korean 4 centers' Registry and 3-vessel FFR FRIENDS study from 2003 to 2014. They compared the prognosis of deferred non-culprit lesions in patients with ACS with those in patients with stable

Table 2. Additional information on the laboratory findings, in-hospital treatment, and smoking status in the groups of patients stratified by the use of IVUS and FFR and initial presentation

STEMI	FFR	IVUS	None	*P*-value
Smoking status				
Current, %	52.85	38.66	41.49	<0.001
Former, %	17.62	20.73	24.83	
In-hospital treatment				
Clopidogrel, %	35.55	34.21	46.33	<0.001
Prasugrel, %	1.42	4.33	1.30	<0.001
Ticagrelor, %	53.30	54.05	39.66	<0.001
Aspirin, %	94.34	96.00	93.04	0.04
GP IIb/IIIa inhibitors, %	27.96	42.34	27.01	<0.001
Laboratory results				
LDL-C, mmol/l, median (IQR)	3.27 (2.40–4.01)	3.21 (2.43–3.96)	3.10 (2.30–3.93)	0.50
Total cholesterol, mmol/l, median (IQR)	5.00 (4.20–5.95)	4.94 (4.09–5.59)	4.90 (4.01–5.79)	0.48
Creatinine, µmol/l, median (IQR)	79.5 (67.0–92.5)	79.0 (69.0–93.0)	81.0 (69.0–98.0)	0.16
Hemoglobin, mmol/l, median (IQR)	8.44 (7.97–9.19)	8.69 (8.07–9.43)	8.8 (8.1–9.5)	0.06
Hematocrit, %, median (IQR)	40.0 (38.0–43.0)	41.00 (38.0–45.0)	41.0 (38.0–44.0)	0.03
NSTEMI	**FFR**	**IVUS**	**None**	***P*-value**
Smoking status				
Current, %	34.57	31.26	27.47	<0.001
Former, %	23.30	25.40	32.49	
In-hospital treatment				
Clopidogrel, %	53.94	52.64	56.89	<0.001
Prasugrel, %	1.72	2.19	1.23	0.01
Ticagrelor, %	28.31	32.85	21.43	<0.001
Aspirin, %	93.86	94.65	92.94	0.07
GP IIb/IIIa inhibitors, %	9.97	17.49	7.46	<0.001
Laboratory results				
LDL-C, mmol/l, median (IQR)	2.77 (1.99–3.78)	2.65 (1.86–3.57)	2.70 (1.91–3.60)	0.37
Total cholesterol, mmol/l, median (IQR)	4.61 (3.60–5.65)	4.32 (3.44–5.33)	4.50 (3.57–5.48)	0.04
Creatinine, µmol/l, median (IQR)	83.5 (72.0–99.0)	85.0 (71.0–105.0)	85.0 (71.0–106.0)	0.47
Hemoglobin, mmol/l, median (IQR)	8.75 (7.94–9.40)	8.69 (7.82–9.31)	8.7 (7.9–9.3)	0.19
Hematocrit, %, median (IQR)	41.0 (38.0–44.0)	41.0 (37.0–44.0)	41.0 (37.0–44.0)	0.95
Unstable angina	**FFR**	**IVUS**	**None**	***P*-value**
Smoking status				
Current, %	24.42	15.90	21.27	0.03
Former, %	33.99	31.28	36.28	
In-hospital treatment				
Clopidogrel, %	54.64	49.34	53.39	0.41
Prasugrel, %	2.12	3.93	0.75	<0.01
Ticagrelor, %	15.92	29.26	11.45	<0.01
Aspirin, %	91.51	95.20	92.28	0.22
GP IIb/IIIa inhibitors, %	1.33	3.06	1.48	0.14
Laboratory results				
LDL-C, mmol/l, median (IQR)	2.30 (1.64–3.00)	2.27 (1.57–3.31)	2.36 (1.71–3.23)	0.57
Total cholesterol, mmol/l, median (IQR)	4.14 (3.35–5.02)	3.96 (3.25–5.12)	4.22 (3.44–5.20)	0.49
Creatinine, µmol/l, median (IQR)	82.0 (70.0–95.0)	82.0 (71.0–100.0)	82.0 (70.0–97.0)	0.64
Hemoglobin, mmol/l, median (IQR)	8.75 (8.07–9.34)	8.69 (7.76–9.18)	8.8 (8.1–9.3)	0.12
Hematocrit, %, median (IQR)	41.0 (38.5–44.0)	41.00 (37.0–43.0)	42.0 (39.0–44.0)	0.01

Categorical data are presented as number of patients (%). Continuous variables are shown as median (interquartile range [IQR])

Abbreviations: GP IIb/IIIa inhibitors, glycoprotein IIb/IIIa inhibitors; LDL-C, low-density lipoprotein cholesterol; other — see Table 1

coronary artery disease based on FFR and did not identify a statistically significant difference in terms of MACE.

In our analysis of 1537 Polish patients with ACS who qualified for FFR over 4 years, we found that performing FFR in both STEMI and NSTEMI is associated with reduced risk of in-hospital death but not with the incidence of stroke, reinfarction, target vessel revascularization, or major bleeding.

Many studies, including randomized trials, have confirmed the significant utility of those extended invasive diagnostics. One of the first and largest randomized trials was the ULTIMATE trial by Zhang et al., which demonstrated a reduction in the incidence of vessel patency abnormalities 12 months after IVUS-guided PCI, compared to an angiography-based PCI strategy [24]. By contrast, in a study of 543 patients randomly assigned to IVUS-guided

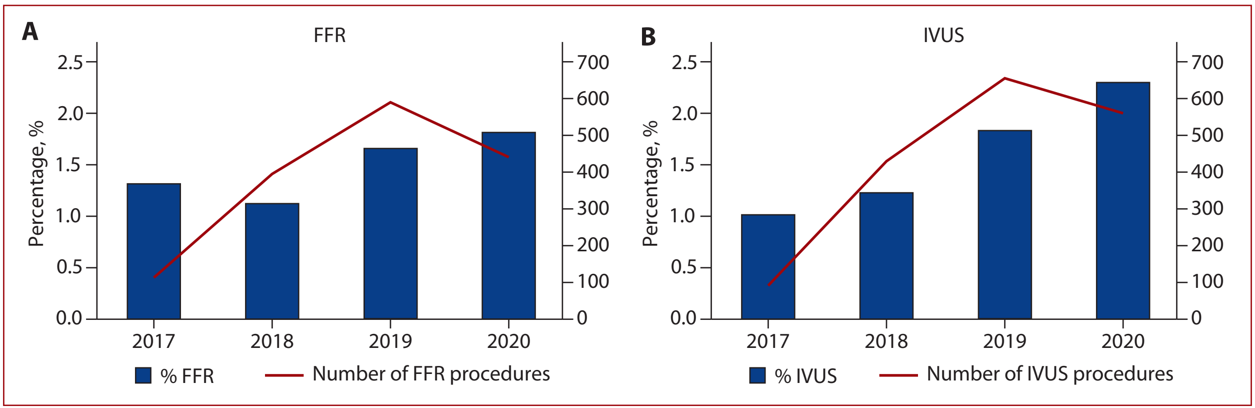

Figure 2. Number and frequency of FFR (**A**) and IVUS (**B**) procedures performed in ACS patients, in consecutive years of the PL-ACS registry (P <0.001)

Abbreviations: see Figure 1

Table 3. Comparison of complication rates depending on procedures performed

Variables	IVUS + FFR (n = 37)	FFR (n = 1500)	IVUS (n = 1690)	None (n = 100 620)	*P*-value
Stroke	0 (0.0)	4 (0.3)	1 (0.1)	206 (0.2)	0.57
ReMI	0 (0.0)	4 (0.3)	6 (0.4)	267 (0.3)	0.88
TVR	0 (0.0)	2 (0.1)	7 (0.4)	327 (0.3)	0.5
Major bleeding	1 (2.7)	11 (0.8)	27 (1.7)	1159 (1.2)	0.09
In-hospital mortality	0 (0.0)	14 (0.9)	39 (2.3)	3714 (3.7)	< 0.001

Data are presented as number of patients (%)

Abbreviations: ReMI, myocardial reinfarction; TVR, target vessel revascularization; other — see Table 1

Table 4. Comparison of the use of FFR and IVUS depending on the clinical presentation of ACS and coronary artery anatomy

	FFR (n = 1537)	IVUS (n = 1727)	*P*-value
STEMI	220 (14.5)	442 (26.2)	<0.001
NSTEMI	914 (60.2)	1009 (59.7)	
UA	384 (25.3)	238 (14.1)	
LM	67 (4.4)	556 (32.2)	<0.001
LAD	1196 (77.8)	979 (56.7)	<0.001
Dg	75 (4.9)	49 (2.8)	0.002
IM	15 (1.0)	17 (1.0)	0.98
Cx	278 (18.1)	252 (14.6)	0.01
OM	47 (2.7)	74 (4.8)	0.002
RCA	239 (15.5)	249 (14.4)	0.36
By-pass	2 (0.1)	7 (0.4)	0.13

Data are presented as number of patients (%)

Abbreviations: ACS, acute coronary syndrome; Cx, circumference branch; Dg, diagonal branch; IM, intermediate branch; LAD, left anterior descending artery; OM, obtuse marginal branch; RCA, right coronary artery; other — see Table 1

(n = 269) or angiography-guided (n = 274) PCI, Kim et al. [25] did not find the IVUS strategy to be superior in terms of the primary endpoint including MACE after 1 year. In a study of 2127 patients who qualified for IVUS-guided PCI and 8235 patients who qualified for PCI directly, Khurshid et al. [26] did not find an advantage of IVUS over direct PCI after 12 months.

In the above analyses, the most important issue is the effect of extended invasive diagnostics on 30-day mortality and 1-year mortality. As a result of our analyses, we confirm that performing FFR is associated with a reduction in 30-day mortality but not with 1-year mortality.

Analyzing the available literature, we found that the results of previous studies are divergent. A large meta-analysis by Liou et al. [27], including 5457 patients with coronary artery disease, found a higher long-term mortality rate using FFR in patients with ACS than in patients with stable angina. In the FUTURE trial, Rioufol et al. [28] randomly assigned 927 patients with stable multivessel coronary artery disease to either a traditional strategy or one based on prior FFR. The study was terminated early, and no advantage of the FFR strategy over the traditional strategy was demonstrated. The latest AISN PTK report also confirmed an increase in the incidence of FFR and IVUS use during PCI compared to 2020 [29]. The authors did not analyze the time of day at which the procedures were performed, but previous studies have shown a similar number of perioperative complications in STEMI patients

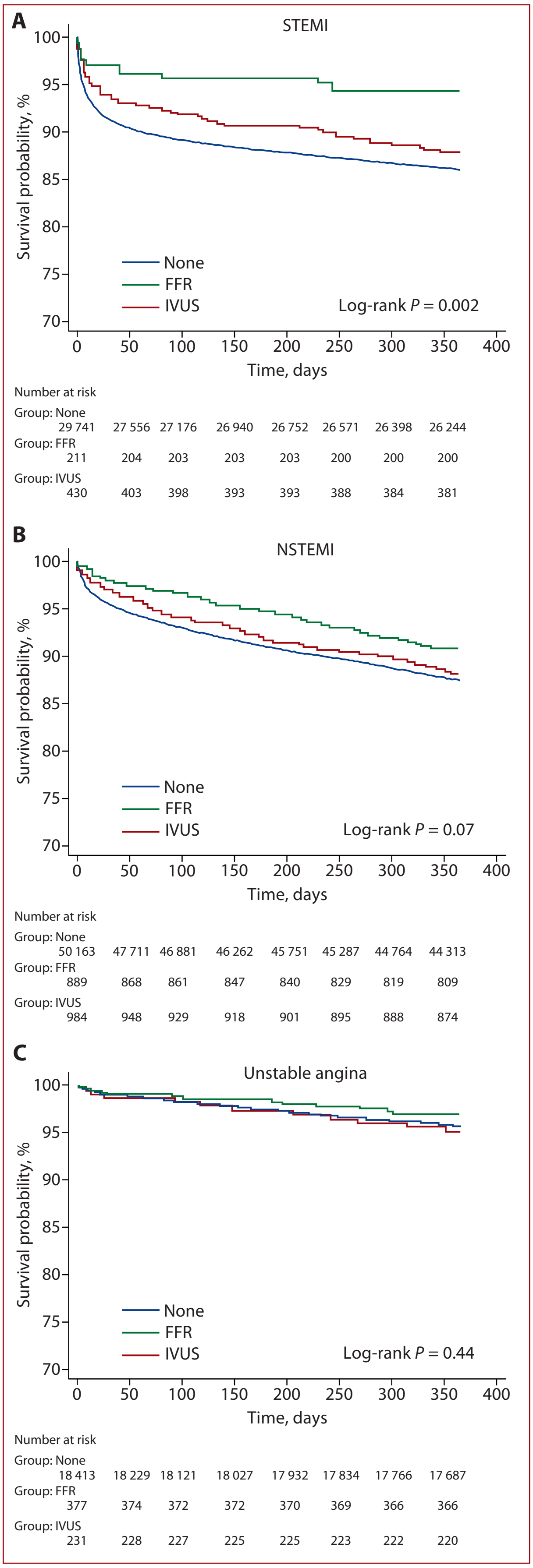

Figure 3. Probability of survival in patients with STEMI (**A**), NSTEMI (**B**), and unstable angina (**C**)

Abbreviations: see Figure 1 and Table 1

treated during on- and off-hours. However, higher perioperative mortality was observed during off-hours [30]. The authors did not demonstrate the effect of FFR and IVUS on improving 1-year survival in patients with ACS, while recent publications have shown that the comprehensive care program called KOS-Infarction significantly improved 1-year survival in patients after myocardial infarction [31].

Intravascular echocardiography and FFR assessment are currently the standard of care for functional assessment in patients with multivessel coronary artery disease or moderate-degree stenosis (40%–90%) in the absence of evidence of ischemia on non-invasive testing. However, the efficacy of this method compared to the traditional strategy for ACS diagnosis cannot be definitively confirmed. The involvement of catheterization laboratories, increasing prevalence of the method, planned randomized trials, and large registry analyses will soon provide many answers to the questions raised.

CONCLUSIONS

In the years 2017–2020 in Poland, the number of FFR and IVUS procedures performed in ACS patients increased significantly.

In the group of patients with ACS who underwent FFR and/or IVUS, significantly lower in-hospital mortality was observed, while no differences in the incidence of stroke, re-myocardial infarction, revascularization of the target vessel, or serious bleeding were observed.

In a multivariable analysis, IVUS or FFR during coronary angioplasty in patients with acute coronary syndrome was not associated with a better distant prognosis (12 months).

Supplementary material

Supplementary material is available at https://journals.viamedica.pl/kardiologia_polska.

Article information

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