Predictors of atrial fibrillation in patients following isolated surgical revascularization. A metaanalysis of 9 studies with 28 786 patients

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Abstract

Introduction: Atrial fibrillation (AF) is one of the most common complication following cardiac surgery AF significantly increases the length of intensive care unit and hospitalization stay and worsens the early and longterm prognosis. The purpose of our study was to apply metaanalysis methodology to find the most important risk factors that predict postoperative atrial fibrillation in patients undergoing isolated surgical revascularization of heart.
Material and methods: After a careful review, nine studies met the inclusion criteria for the metaanalysis. A total of 28 786 patients were assessed in the metaanalysis.
Results: Postoperative atrial fibrillation appeared in 7019 patients (24.4%), with mean age 67.1±2.9, among which there were 5283 men (75.3%) and 1736 women (24.7%). The age of patients without postoperative atrial fibrillation was lower (62.2±3.3), however the sex distribution was very similar (74.4% men vs. 25.6% women). The following predictors of postoperative atrial fibrillation (AF SCORE) were significant; advanced age (SMD 0.57), preoperative ejection fraction (SMD –0.12), the history of atrial fibrillation (OR 2.07), arterial hypertension (1.27), heart failure (1.47), peripheral vascular disease (1.37), chronic obstructive pulmonary disease (1.31), neurological event (1.44), renal failure (1.46), significant stenosis of left main coronary artery before the surgery (1.14), and postoperative use of inotropic therapy (1.76).
Conclusions: The validated AF SCORE for developing postoperative atrial fibrillation may used to stratify patients undergoing surgical revascularization into high-risk and low-risk groups. It might be useful to appropriately target high-risk patients for aggressive prophylactic treatment in the preoperative period.

Key words: atrial fibrillation, cardiac surgery, metaanalysis, predictors, risk stratification.

Introduction

Atrial fibrillation (AF) is one of the most common complications that patients experience following cardiac surgery. It occurs with a frequency of 20 to 40%, usually appearing between 2 and 4 days after the procedure and often recurs during the month following surgery. Recently atrial

fibrillation has been noted to be occurring more frequently. This is probably due to the fact that less physically fit patients are being allowed to have surgery. These patients often also have associated essential organic changes of myocardium. More postoperative arrhythmias could be also a result of the broadening of the group of patients undergoing open-heart operations and a reduction in the list of contraindications for cardiac surgery [1-3].

Reviewing the literature regarding postoperative atrial fibrillation shows that AF significantly increases the length of intensive care unit (ICU), stay in hospital and worsens the early and longterm prognosis. Suitable treatment and prevention of postoperative AF is important for the patients' improved health, faster rehabilitation, and also for the reduction of hospitalization costs [4-7].

Many authors have tried to evaluate and select the predictors of postoperative atrial fibrillation. On the basis of available studies, there are so many pre-, intra- and postoperative risk factors that have been analysed, that it makes it virtually impossible, to effectively predict the risk of all types of patients who are going to have cardiac surgery. Surgeons are unable to determine state which of the risk factors could have the strongest influence on the occurrence of postoperative atrial fibrillation. Knowing which are the most important predictors of post-AF would enable medics to implement suitable pre- and postoperative treatment which would in consequence decrease the cost of hospitalization. No previous studies have used the metaanalysis to evaluate the predictors of postoperative atrial fibrillation in this group of patients [8-10].

The purpose of our study was to apply metaanalysis methodology to find the most important risk factors for atrial fibrillation in patients subjected to isolated surgical revascularization of heart.

Material and methods

Data sources

Computerized literature searches were performed using Medline, EMBASE, and SCOPUS databases. To find the most current studies, the year 2000 was chosen as the starting date. In addition, references from retrieved review articles and original investigations were examined. The following key words were used either alone or in various combinations for computer searches: "atrial fibrillation"; "CABG"; "cardiac revascularization"; "cardiac surgery"; "OPCAB"; "predictors"; "postoperative" and "risk factors". The titles and abstracts of studies that were identified in the computerized searches were examined to exclude any articles that were clearly irrelevant. The full text of the remaining articles was retrieved, and each article was read to determine whether it contained information on the topic of interest. Because computer searches have been shown to yield less than two thirds of relevant articles in some research areas, reference lists from original and review articles were reviewed to identify any studies that had not been previously identified and appeared to contain information on the topic of interest. Searches by hand of selected journals related to cardiac surgery were also carried out.

Study selection

Inclusion criteria for this metaanalysis included the following: (1) describing patients subjected to isolated surgical revascularization (CABG – *Coronary Artery Bypass Grafting* and/or OPCAB – *Off-Pump Coronary Artery Bypass*); (2) evaluation of perioperative risk factors of postoperative atrial fibrillation; (3) published in the English language; (4) indexed between January 2000 and September 2007. Studies published in foreign language journals were not included because of the potential error in the translation and interpretation of findings. Abstracts from conference proceedings, doctoral dissertations, and Master's theses were also not included because those sources are unlikely to report substantive research findings that have not been published elsewhere. Studies meeting the inclusion criteria were examined to ensure that the same patients were not included in more than one study.

Data extraction

All data from selected studies were independently extracted by two of the coauthors. The major categories of variables that were coded include (1) study characteristics (i.e. author, year, and number of subjects), (2) the detailed characteristics of subjects (i.e. gender, age, history), and (3) main outcomes (predictors of postoperative AF, length of ICU stay and hospitalization) (Tables I-III). All data were collected independently for patients with and without postoperative atrial fibrillation.

Statistical analysis

Statistical analysis was performed with the R environment. For all metaanalyses first statistical heterogeneity was assessed with chi-squared tests and quantified with the I^2 statistics which describes the percentage of total variation across studies that is attributable to heterogeneity rather than chance. The influence analysis (estimates were calculated omitting one study at a time) was performed if studies were not homogenous.

For binary outcome data fixed (for homogenous studies) or random effects were calculated (measured by OR – odds ratio or RR – relative risk) with the Mantel-Haenszel method for pooling. For continuous outcome data fixed and random effects were measured by SMD – standardized mean

Table I. Characteristics of studies used in the metaanalysis

Study reference	No. of patients	Sex: M/F n (%)	Age	AF occurrence n (%)
Maggee et al., 2007 [11]	19083	14569/4514 (76.3/23.7)	64.7±10.2*	4215 (21.5)
Turk et al., 2007 [12]	267	207/60 (77.5/22.5)	58.4±7.4*	64 (23.9)
Nisanoglu et al., 2007 [13]	426	296/130 (69.5/30.5)	70.1±4.4	91 (21.4)
Sedrakyan et al., 2006 [14]	1209	871/338 (72.0/28.0)	64.8±10.7*	386 (31.9)
Banach et al., 2006 [15]	1200	799/401 (66.6/33.4)	61.0±2.40	278 (23.2)
Mathew et al., 2004 [16]	4657	3716/941 (79.8/20.2)	63.8±8.4*	1503 (32.3)
Svedjeholm et al., 2000 [17]	775	604/171 (77.9/22.1)	64.6±8.7	229 (29.5)
Ascione et al., 2000 [18]	200	161/39 (80.5/19.5)	61.9±6.5	47 (23.5)
Stamou et al., 2000 [19]	969	645/324 (67.0/33.0)	62.7±11.1*	206 (21.3)

**data not reported; presented data are based on the authors' re-calculations*

difference. All measures were reported with 95% CI and graphically presented using forest plots.

Results

Study and patients characteristics

The initial computerized searches identified 27 potentially relevant articles using the search terms. A careful review resulted in 9 studies that could potentially have met the inclusion criteria for the metaanalysis. The reference lists from these 9 articles as well as from review articles were examined to identify any additional potentially relevant studies that had not been previously identified. Searches by hand of selected journals related to general medicine and cardiology were also performed. However the result of these searches didn't yield any additional articles [11-19].

A total of nine studies were analyzed for the metaanalysis. Three of the studies were conducted in the United States, two in Turkey, with the remaining four in United Kingdom, Sweden, Poland and Italy respectively. A total of 28 786 patients were assessed in the metaanalysis. The number of subjects in each study ranged between 200 and 19083 (mean: 2878.6±5754.7 subjects). The mean age across all nine studies was 63.4±3.4, there were 21868 men (76.0%) and 6918 women (24.0%) (Table I) [11-19].

Postoperative atrial fibrillation occurred in 7019 patients (24.4%), with mean age 67.1±2.9, among whom there were 5283 men (75.3%) and 1736 women (24.7%). The age of patients without postoperative atrial fibrillation was essentially lower (62.2±3.3), however the sex distribution was very similar (16,585 men [74.4%] and 5707 women [25.6%]).

Metaanalyses

Twenty nine pre- and postoperative variables, were evaluated in the meta-analysis. Twenty two variables selected in at least four of the studies were included in the final statistical analysis (Table IV).

Patients with postoperative atrial fibrillation were older than patients without arrhythmias after surgery (67.1±2.9 vs. 62.2±3.3) (Table II, III). Age was a significant risk factor for postoperative atrial fibrillation (SMD 0.57; 95% CI 0.54-0.60; p<0.0001), with a heterogeneity index of I^2=48.3% (Figure 1). The effect size (ES) of age on postoperative AF could be defined as an average. The highest decrease in heterogeneity (to I^2=37.5%, for SMD 0.57; 95% CI 0.54-0.60; p<0.0001) was observed by withdrawing the study by Nisanoglu et al.

The preoperative left ventricular ejection fraction (LVEF) of patients with postoperative atrial fibrillation was lower then in patients without AF after surgery (47.7±1.5 vs. 49.4±1.2) (Table II, III). LVEF was a significant predictor of postoperative atrial fibrillation occurrence (SMD –0.1162; 95% CI (–0.1478)–(–0.0846); p<0.0001) with a heterogeneity index of I^2=0% (Figure 2). The effect size (ES) of LVEF on postoperative AF could be defined as a small. Similar results were observed when analyzing the influence of preoperative heart failure. This significantly affected the increased risk of postoperative atrial fibrillation (OR 1.47; 1.37-1.58; p<0.0001; heterogeneity index I^2=0%) (Figure 3).

Many studies have reported a direct correlation between pre- and postoperative atrial fibrillation. We observed that preoperative AF increased over twofold the risk of postoperative atrial fibrillation (OR 2.07; 95% CI 1.90-2.27; p<0.0001), with a heterogeneity index of I^2=92% (Figure 4). Withdrawing the study by Magge et al. we observed the highest decrease in heterogeneity and there was an even stronger influence of preoperative arrhythmias on postoperative AF occurrence (OR 3.10; 95% CI 2.62-3.65; p<0.001).

68.3% patients subjected to isolated surgical revascularization with postoperative AF and 64.5%

Table II. Characteristics of patients with postoperative AF included in the studies used in the metaanalysis. Only variables available at least in four studies have been included (*in the Mathew et al. study there were two groups of patients) (# NR – data not recorded) (LVEF, left ventricular ejection fraction; MI, myocardial infarction; MCA, left main coronary artery; COPD, chronic obstructive pulmonary disease; CABG, coronary artery bypass grafting; ACEI, angiotensin-converting enzyme inhibitor; IABP, intra-aortic balloon pump; ICU, intensive care unit)

	Maggee et al., 2007 [11]	Turk et al., 2007 [12]	Nisanoglu et al., 2007 [13]	Sedrakyan et al., 2006 [14]	Banach et al., 2006 [15]	Mathew et al., 2004 [16]	Svedjeholm et al., 2000 [17]	Ascione et al., 2000 [18]	Stamou et al., 2000 [19]
Number of patients (n)	4215	64	91	386	278	1503	229	47	206
Preoperative data n (%):									
Age (n)	67.6±9.6	61.0±7.4	71.2±4.6	67.2±7.8	66.0±7.8	67.8±8.4	68.7±10.2	65.0±4.1	69.0±10.0
Sex: male	3168 (75.2)	50 (78.1)	66 (72.5)	280 (72.5)	184 (66.2)	1185 (78.8)	177 (77.3)	36 (76.6)	137 (66.5)
LVEF (%)	49.0±12.7	47.2±8.8	46.3±12.4	46.9±14.3	46.7±8.4	NR	50±11	NR	NR
Atrial fibrillation	500 (11.9)	NR	NR	NR	141 (50.7)	229 (15.2)	NR	NR	NR
Arterial hypertension	3115 (73.9)	37 (57.8)	40 (44.0)	100 (25.9)	202 (72.7)	1058 (70.4)	89 (38.8)	27 (57.0)	126 (61.2)
Prior MI	2058 (48.8)	24 (37.5)	65 (71.4)	281 (72.8)	NR	953 (63.4)	48 (20.8)	14 (30.0)	NR
LMCA stenosis >70%	1112 (26.4)	63 (98.0)	4 (4.4)	101 (26.2)	NR	NR	20 (8.8)	NR	NR
Heart failure	703 (16.8)	NR	NR	76 (19.7)	17 (6.1)	612 (40.7)	36 (15.7)	NR	49 (23.8)
Valvular disease	NR	NR	NR	94 (24.4)	NR	413 (27.5)	17 (7.4)	NR	NR
Diabetes mellitus	1287 (30.5)	16 (25.0)	12 (13.2)	109 (28.2)	74 (26.6)	963 (64.1)	27 (11.8)	5 (11.0)	42 (20.4)
Vascular disease	661 (15.7)	NR	5 (5.5)	79 (20.4)	NR	298 (19.8)	NR	NR	NR
Prior neurological event	290 (6.9)	NR	21 (23.1)	NR	NR	199 (13.2)	NR	NR	22 (10.7)
COPD	883 (20.9)	8 (12.5)	22 (24.2)	71 (18.4)	11 (4.0)	213 (14.2)	18 (7.9)	NR	16 (7.8)
Renal failure	174 (4.1)	NR	4 (4.4)	29 (7.5)	14 (5.0)	NR	NR	NR	6 (2.9)
Prior CABG surgery	295 (7.0)	NR	NR	17 (4.4)	12 (4.3)	84 (5.6)	6 (2.6)	NR	NR
Beta-blocker therapy	2078 (49.3)	24 (37.5)	40 (44.4)	NR	187 (67.3)	1012 (67.3)	NR	21 (45.0)	80 (38.8)
ACEI therapy	1409 (33.4)	NR	NR	NR	NR	708 (47.1)	NR	11 (23.0)	NR
Postoperative data n (%):									
Inotropic treatment	NR	27 (42.2)	17 (18.7)	NR	34 (12.2)	NR	54 (23.6)	12 (26.0)	NR
IABP required	NR	NR	4 (4.4)	NR	4 (1.4)	NR	5 (2.2)	NR	7 (3.4)
Mortality	NR	1 (1.6)	2 (2.2)	NR	16 (5.8)	NR	2 (0.9)	1 (2.1)	7 (3.4)
Length of ICU stay (days)	NR	NR	3.8±4.7	NR	2.8±1.9	NR	2.3±4.3	1.9±2.1	2.1±3.2
Hospitalization (days)	NR	8.3±1.6	7.8±4.4	NR	12.9±7.8	NR	10.7±5.9	7.7±5.9	8.7±6.1

Table III. Characteristics of patients without postoperative AF included in the studies used in the metaanalysis. Only variables available at least in four studies have been included (*in the Mathew et al. study there were two groups of patients) (#NR – data not recorded). See Table II for definition of abbreviations

	Maggee et al., 2007 [11]	Turk et al., 2007 [12]	Nisanoglu et al., 2007 [13]	Sedrakyan et al., 2006 [14]	Banach et al., 2006 [15]	Mathew et al., 2004 [16]	Svedjeholm et al., 2000 [17]	Ascione et al., 2000 [18]	Stamou et al., 2000 [19]
Number of patients (n)	15405	203	335	823	922	3154	534	153	763
Preoperative data n (%):									
Age (n)	61.7±10.7	57.6±7.5	69.8±4.4	62.9±10.8	60.0±13.4	61.8±9.9	63.4±8.8	61.7±9.9	61.0±12.0
Sex: male	11401 (74.0)	157 (77.3)	230 (68.7)	591 (71.8)	615 (66.7)	2531 (80.2)	427 (80.0)	125 (81.7)	508 (66.6)
LVEF (%)	61.7±10.7	47.7±8.8	48.7±9.8	49.1±13.3	49.7±8.2	NR	51.0±11.0	NR	NR
Atrial fibrillation	1122 (7.3)	NR	NR	NR	195 (20.9)	191 (6.1)	NR	NR	NR
Arterial hypertension	10550 (68.5)	123 (60.6)	138 (41.0)	221 (26.9)	614 (66.6)	2057 (65.2)	151 (28.3)	83 (54.0)	442 (58.0)
Prior MI	7099 (46.1)	85 (41.9)	244 (73.0)	721 (87.6)	NR	1999 (63.4)	86 (16.1)	57 (37.0)	NR
LMCA stenosis >70%	3678 (23.9)	159 (78.3)	17 (5.0)	207 (25.2)	NR	NR	54 (10.1)	NR	NR
Heart failure	1771 (11.5)	NR	NR	136 (16.5)	35 (3.8)	1029 (32.6)	67 (12.5)	NR	131 (17.2)
Valvular disease	NR	NR	NR	153 (18.6)	NR	479 (15.2)	18 (3.4)	NR	NR
Diabetes mellitus	4691 (30.4)	42 (20.7)	67 (20.0)	267 (32.4)	214 (23.3)	979 (31.0)	60 (11.2)	27 (18.0)	137 (18.0)
Vascular disease	1796 (11.7)	NR	11 (3.0)	169 (20.5)	NR	476 (15.1)	NR	NR	NR
Prior neurological event	812 (6.9)	NR	79 (23.0)	NR	NR	282 (8.9)	NR	NR	5 (0.7)
COPD	2594 (16.8)	20 (9.9)	67 (20.0)	141 (17.1)	41 (44.5)	319 (10.1)	31 (5.8)	NR	47 (6.2)
Renal failure	468 (3.0)	NR	3 (0.8%)	34 (4.1)	30 (3.3)	NR	NR	NR	11 (1.4)
Prior CABG surgery	1097 (7.1)	NR	NR	44 (5.3)	35 (3.8)	186 (5.9)	4 (0.7)	NR	NR
Beta-blocker therapy	7476 (48.5)	72 (35.5)	140 (42.0)	NR	710 (77.0)	2223 (70.5)	NR	50 (33.0)	344 (45.1)
ACEI therapy	4473 (29.0)	NR	NR	NR	NR	1325 (42.0)	NR	55 (36.0)	NR
Postoperative data n (%):									
Inotropic treatment	NR	69 (34.0)	41 (12.0)	NR	71 (7.7)	NR	75 (14.0)	17 (11.0)	NR
IABP required	NR	NR	13 (3.8)	NR	16 (1.7)	NR	1 (0.2)	NR	13 (1.7)
Mortality	NR	3 (1.5)	11 (3.2)	NR	28 (3.0)	NR	1 (0.2)	1 (0.7)	6 (0.8)
Length of ICU stay (days)	NR	NR	2.5±1.3	NR	2.2±1.4	NR	1.3±1.0	1.2±1.1	1.2±1.4
Hospitalization (days)	NR	7.7±2.0	7.1±2.6	NR	9.4±5.2	NR	9.2±2.3	6.9±4.7	7.2±4.5

Table IV. Detailed results of the metaanalysis. See Table II for definition of abbreviations (*SMD)

Variable	I^2 index (95% CI)	OR /SMD	95% CI	p-value
Age	48.3% (0-75)	0.57*	0.54-0.59	<0.0001
Sex	0% (0-44.4)	1.02	0.96-1.09	0.50
Preoperative variables:				
LVEF	0% (0-53.4)	-0.12*	-0.15-(-0.08)	<0.0001
Atrial fibrillation	92% (82.8-96.3)	2.07	1.90-2.27	<0.0001
Arterial hypertension	3.1% (0-63.5)	1.27	1.20-1.35	<0.0001
Prior MI	86.1% (74.7-92.4)	1.05	0.99-1.11	0.11
LMCA stenosis >70%	54.7% (0-83.3)	1.14	1.06-1.23	0.0004
Heart failure	0% (0-38.8)	1.47	1.37-1.58	<0.0001
Valvular disease	29.3 (16-72.5)	0.97	0.92-1.08	0.43
Diabetes mellitus	0% (0-58.8)	1.00	0.94-1.06	0.91
Vascular disease	29.3% (0-72.5)	1.37	1.27-1.48	<0.0001
Prior neurological event	86.7% (71.2-93.9)	1.44	1.29-1.61	<0.0001
COPD	10.6% (0-68.5)	1.31	1.22-1.41	<0.0001
Renal failure	11.2% (0-81.5)	1.46	1.25-1.71	<0.0001
Prior CABG surgery	43.9% (0-77.8)	0.98	0.88-1.10	0.75
Beta-blocker therapy	66% (27.9-84.0)	0.97	0.92-1.03	0.34
ACEI therapy	42.9% (11.9-54.3)	0.99	0.94-1.09	0.56
Postoperative variables:				
Inotropic treatment	0% (0-55.7)	1.76	1.40-2.21	<0.0001
IABP required	41.2% (0-67.2)	0.92	0.91-1.01	0.14

without such arrhythmias were diagnosed as having arterial hypertension (HA) before the surgery (Table II, III). HA was a significant predictor of postoperative atrial fibrillation (OR 1.27; 95% CI 1.20-1.35; p<0.0001), with a heterogeneity index of I^2=3.1% (Figure 5).

It is worth noting that the analysis of predictors of postoperative AF showed the importance of significant changes in left main coronary artery (LMCA >70%) on the appearance of postoperative atrial fibrillation (OR 1.14; 1.06-1.23; p=0.0004;

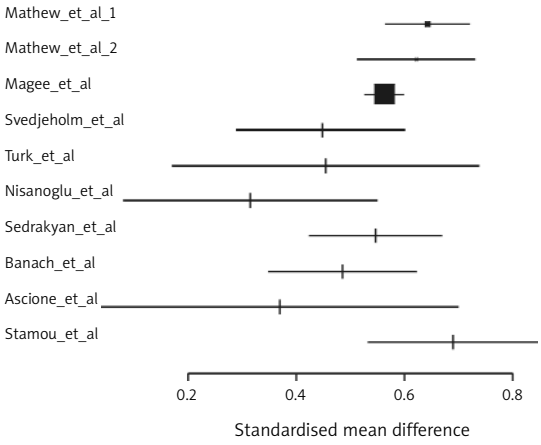

Figure 1. The effect size of age on postoperative atrial fibrillation (p<0.0001)

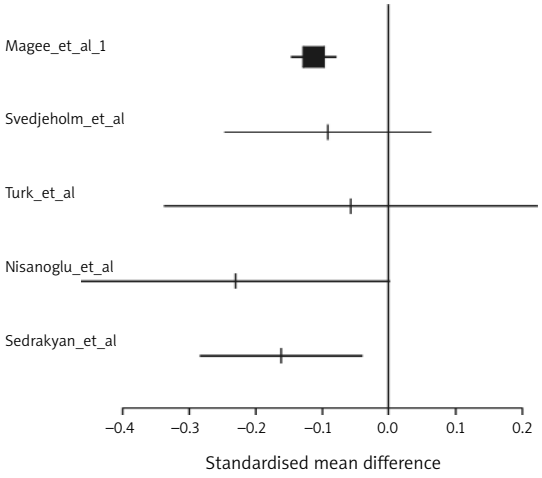

Figure 2. The effect size of preoperative LVEF on postoperative atrial fibrillation (p<0.0001)

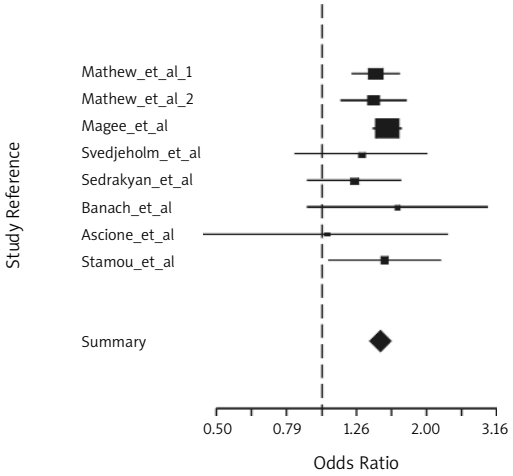

Figure 3. The influence of preoperative heart failure on postoperative AF (p<0.0001)

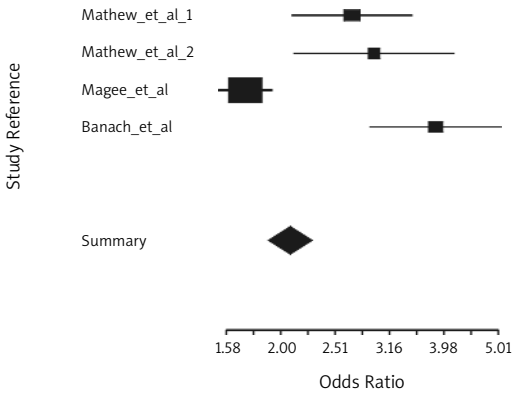

Figure 4. The influence of preoperative AF on postoperative atrial fibrillation (p<0.0001)

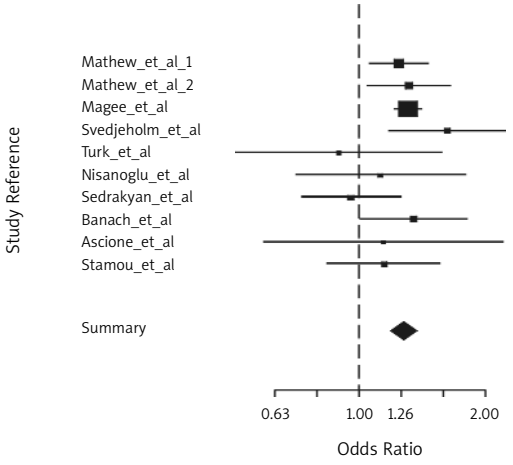

Figure 5. The influence of preoperative arterial hypertension on postoperative atrial fibrillation (p<0.0001)

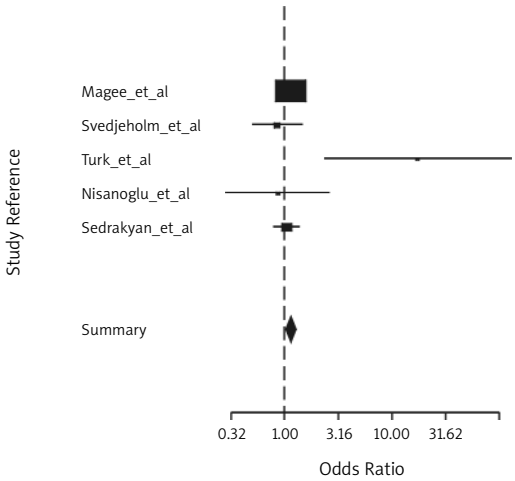

Figure 6. The influence of LMCA significant changes occurrence on postoperative atrial fibrillation (p=0.0004)

I^2=54.7%) (Figure 6). When we withdrew the study by Turk et al. observed the highest decrease of the heterogeneity (I^2=0%, OR 1.13; p=0.0015).

The metaanalysis confirmed an unequivocal way that some preoperative concomitant diseases significantly increased the risk of postoperative atrial fibrillation, including: peripheral vascular disease (OR 1.37; 1.27-1.48; p<0.0001) (Figure 7), prior neurological history (OR 1.44; 1.29-1.61; p<0.0001) (Figure 8), chronic obstructive pulmonary disease (OR 1.31; 1.22-1.41; p <0.0001) (Figure 9) and a history of renal failure (OR 1.46; 1.25-1.71; p<0.0001) (Figure 10).

From among all analyzed postoperative predictors, only postoperative inotropic treatment turned out to be significant (OR 1.76; 1.40-2.21; p<0.0001), with a heterogeneity index of I^2=0% (Figure 11). All the most important predictors of postoperative atrial fibrillation (AF SCORE) are presented in Table 5.

According to the available data, postoperative atrial fibrillation significantly influences the length of ICU stay, hospitalization and mortality. Our metaanalysis confirms these reports. We showed that postoperative atrial fibrillation prolongs the length of intensive care unit stay (SMD 0.43; 0.36-0.51; p<0.0001; I^2=0%) (Figure 12) and the time of hospitalization (SMD 0.40; 0.32-0.47; p<0.0001; I^2=63.3%) (Figure 13). The effect size (ES) between length of ICU and hospitalization stay and postoperative AF could be defined as an average.

Postoperative atrial fibrillation significantly worsens the prognosis of patients subjected to

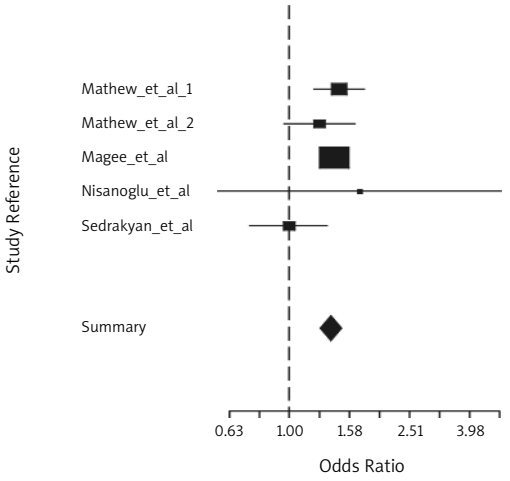

Figure 7. The influence of preoperative peripheral vascular disease on postoperative atrial fibrillation (p<0.0001)

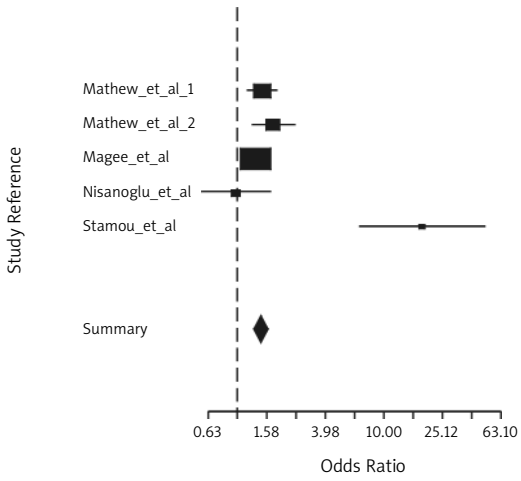

Figure 8. The influence of preoperative neurological history on postoperative atrial fibrillation (p<0.0001)

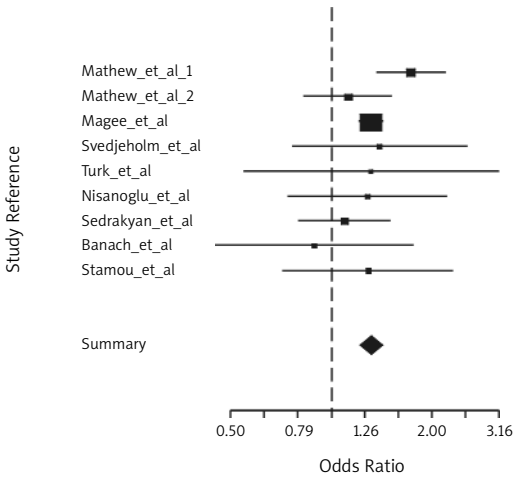

Figure 9. The influence of preoperative chronic obstructive pulmonary disease on postoperative atrial fibrillation (p<0.0001)

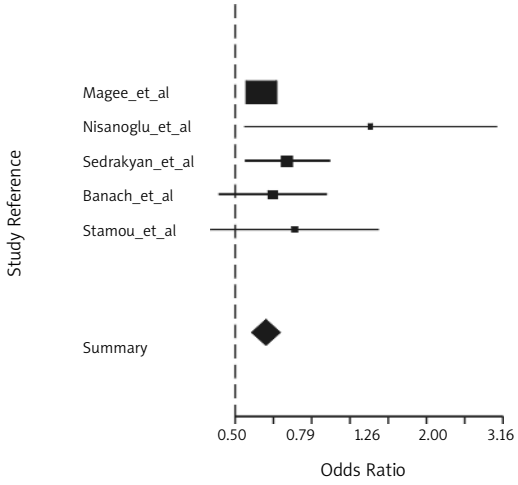

Figure 10. The influence of preoperative renal failure on postoperative atrial fibrillation (p<0.0001)

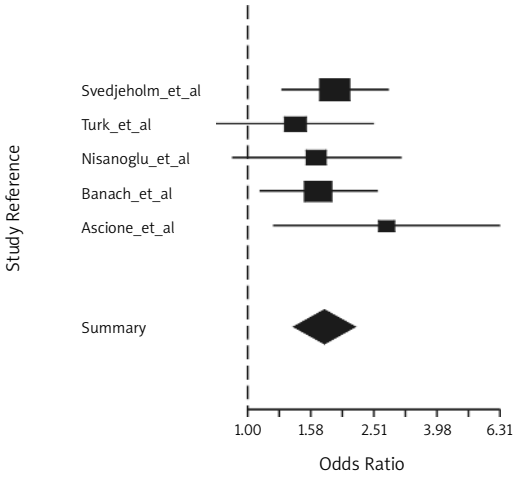

Figure 11. The influence of postoperative application of inotropic therapy on postoperative atrial fibrillation (p<0.0001)

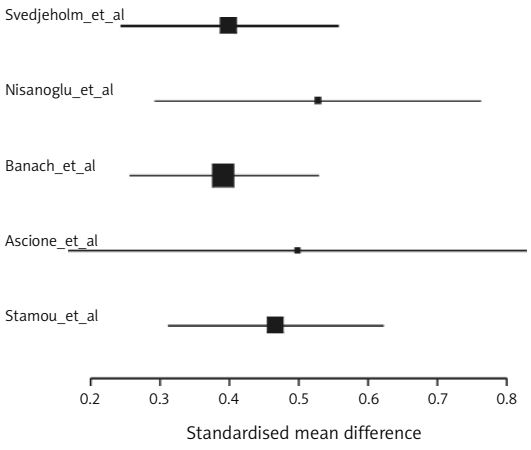

Figure 12. The effect size between ICU stay and postoperative atrial fibrillation (p<0.0001)

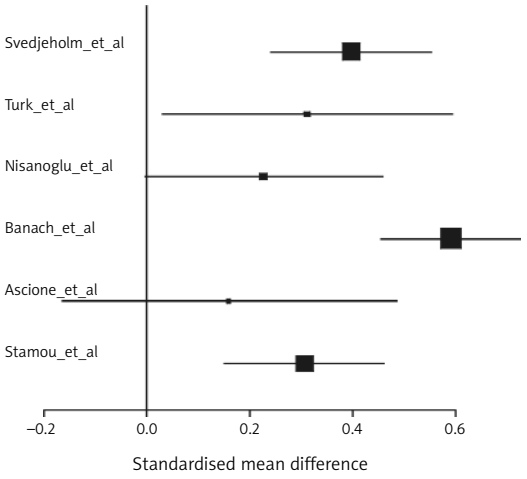

Figure 13. The effect size between the time of hospitalization and postoperative atrial fibrillation (p<0.0001)

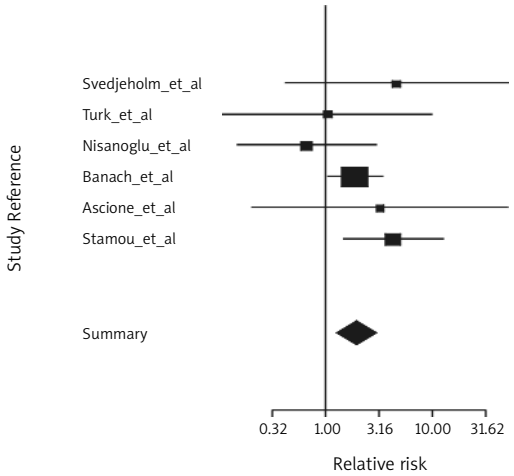

Figure 14. The relative risk (RR) of death in patents with postoperative atrial fibrillation (p<0.01)

isolated surgical revascularization. According to the metaanalysis the occurrence of AF in patients after cardiac surgery increased the risk of death by almost twofold (RR=1.96; 95% CI 1.26-3.06; p<0.01) (Figure 14).

Discussion

Atrial fibrillation is one of the most common complications following cardiac surgery. It has an influence on a worsening of the postoperative condition, the length of the hospitalization and considerably increases hospital costs. There are many studies being undertaken with the aim of determining the predictors of postoperative AF. However, so many mentioned risk factors have been assessed, that it is very difficult to stratify the risk of patients subjected to cardiac surgery. Therefore there was a need to undertake a metaanalysis investigating the most important predictors of postoperative atrial fibrillation in order to create an atrial fibrillation risk score [3, 8-10, 20, 21].

In the available studies to this point some variables, such as advanced age, low LVEF, history of atrial fibrillation, heart failure, chronic obstructive pulmonary disease, postoperative application of inotropic therapy and prolonged mechanical ventilation have been analysed [11-15, 17-19]. However, for the first time in 2004 Mathew et al. made an attempt to develop a comprehensive risk index that could better identify patients at risk for atrial fibrillation [16]. 4657 patients undergoing CABG surgery at 70 centers located within 17 countries, were included in the study. Atrial fibrillation occurred in 32.3% patients. According to the statistical analysis the following risk factors were associated with postoperative atrial fibrillation: advanced age (odds ratio [OR] for 10-year increase 1.75); history of atrial fibrillation (OR 2.11), chronic obstructive pulmonary disease (1.43); simultaneous valve surgery (1.74); and postoperative withdrawal of a beta-blocker (1.91) or angiotensin converting enzyme inhibitor (1.69). Conversely, reduced risk was associated with postoperative administration of beta-blockers (0.32), ACE inhibitors (0.62), potassium supplementation (0.53) and nonsteroidal anti-inflammatory drugs (0.49). The authors also confirmed that atrial fibrillation after CABG surgery was associated with important complications [16].

In 2007 Magee et al. attempted to select the most important factors for postoperative atrial fibrillation. Utilizing perioperative risk factors, the authors sought to develop an algorithm to predict the relative risk of developing postoperative atrial

Table V. Predictors of postoperative atrial fibrillation. AF SCORE (*SMD)

Predictor	OR/SMD	p-value
Age	0.57*	<0.0001
LVEF prior to the surgery	-0.12*	<0.0001
Atrial fibrillation prior to the surgery	2.07	<0.0001
Postoperative inotropic treatment	1.76	<0.0001
Heart failure in the history	1.47	<0.0001
Renal failure in the history	1.46	<0.0001
Neurological event prior to the surgery	1.44	<0.0001
Vascular disease in the history	1.37	<0.0001
COPD	1.31	<0.0001
Arterial hypertension	1.27	<0.0001
LM stenosis >70%	1.14	0.0004

fibrillation in patients undergoing CABG. Almost twenty thousands patients from the American Society of Thoracic Surgeons Database were included to the study. Perioperative risk factors were used to develop a logistic regression equation predictive for the development of postoperative atrial fibrillation. The final model was used to compare the predicted probability of atrial fibrillation with the known outcome in the patients divided into deciles by probability. A regression model was developed with 14 significant indicators. Those showing the greatest predictive influence included the patient age, the need for prolonged ventilation, the use of cardiopulmonary bypass, and preoperative arrhythmias. It was suggested that a validated predictive risk algorithm for developing postoperative atrial fibrillation could reliably stratify patients undergoing CABG into high-risk and low-risk groups, and it might be used preoperatively to appropriately target high-risk patients for aggressive prophylactic treatment [11].

Our metaanalysis using nine studies with almost 30,000 patients gave very valuable results. It confirmed well known predictors, mentioned in many studies, such as: advanced age; history of atrial fibrillation and chronic obstructive pulmonary disease. On the other hand, it also proved the important role of other predictors: history of arterial hypertension (OR 1.27), heart failure (1.47), left main coronary artery stenosis before the surgery (1.14), and coexistence of other diseases prior the surgery – peripheral vascular disease (1.37), neurological history (1.44) and renal failure (1.46). We also confirmed the reports of some authors that postoperative use of catecholamines significantly increased the risk of atrial fibrillation (1.76).

The present metaanalysis contradicted previous studies that found that preoperative administration of beta-blockers and ACE inhibitors reduced the risk of postoperative atrial fibrillation. Our results did not support the finding that these variables could be considered as protective factors. The surgery with OPCAB technique was also discussed as a potential factor which could decrease the risk of atrial fibrillation following surgical revascularization. In the performed metaanalysis, we didn't observe any such significant correlations [22].

We also showed that postoperative atrial fibrillation was significantly connected with the prolonged length of intensive care unit stay and the time of hospitalization. Importantly, our metaanalysis confirmed that postoperative AF worsened the prognosis of patients subjected to isolated surgical revascularization by increasing the risk of death by almost twofold [23].

The study has some limitations, mainly connected with the fact that we analyzed only articles published in last seven years. The complete metaanalysis, including all studies that have investigated predictors of postoperative atrial fibrillation, in last 25 years is still being continued in order to confirm the obtained results.

Conclusions

On the basis of performed metaanalysis from nine studies with 28 786 patients we selected the most important factors that predicted postoperative atrial fibrillation (AF SCORE). These included: advanced age, preoperative ejection fraction, the history of atrial fibrillation, arterial hypertension, heart failure, peripheral vascular disease, chronic obstructive pulmonary disease, neurological event, renal failure, and significant stenosis of left main coronary artery before the surgery, as well as postoperative application of inotropic therapy. The validated AF SCORE for developing postoperative atrial fibrillation may be used to stratify patients undergoing surgical revascularization into high-risk and low-risk groups. It might be useful to appropriately target high-risk patients for aggressive prophylactic treatment in the preoperative period.

Acknowledgments

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